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MEDICAL AND SURGICAL MEMOIRS:

CONTAINING

INVESTIGATIONS ON THE GEOGRAPHICAL DISTRIBUTION, CAUSES,
NATURE, RELATIONS AND TREATMENT

OF

VARIOUS DISEASES,

1855-1876.

BY JOSEPH JONES, M. D.,

Professor of Chemistry and Clinical Medicine, Medical Department University of Louisiana: Visiting Physician of Charity Hospital; Honorary Member of the Medical Society of Virginia; Formerly Surgeon in the Provisional Army of the Confederate States.

VOLUME I.

INTRODUCTION TO THE STUDY OF DISEASES OF THE NERVOUS SYSTEM. INVESTIGATIONS ON TRAUMATIC TETANUS, EPILEPSY, PARALYSIS, AND CEREBRO-SPINAL MENINGITIS. CLINICAL OBSERVATIONS ON DISEASES OF THE LYMPHATIC AND CIRCULATORY SYSTEMS, AND OF THE LIVER AND KIDNEYS. INVESTIGATIONS AND RESEARCHES ON PNEUMONIA. OBSERVATIONS ON DISEASES OF THE OSSEOUS SYSTEM. ILLUSTRATED BY 800 CASES OF DISEASE, 400 PHYSIOLOGICAL EXPERIMENTS, 95 ANALYSES OF THE BLOOD AND URINE, AND 60 TABLES, ILLUSTRATING THE SYMPTOMS AND MORTALITY OF DISEASES UNDER DIFFERENT MODES OF TREATMENT AND IN DIFFERENT CLIMATES.

Vince Malum Bono.

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TO THE MEMORY

OF

MY MOTHER,

MARY JONES,

AND OF

MY FATHER,

Rev. CHARLES C. JONES, D. D.

THIS VOLUME

IS

AFFECTIONATELY DEDICATED.

PREFACE.

THE object of the Medical and Surgical Memoirs, is to place in an accessible form for the use of Students and Practitioners of Medicine, the results of investigations and researches, which the author has conducted during the past twenty years, and which embrace the eventful period of the American Civil War, 1861–1865.

Situated at a distance from public libraries, and deprived of personal intercourse with learned men and original investigators, of congenial pursuits, whose counsel might have removed doubts, and directed and stimulated exertion, the author has labored under disadvantages, which necessitated the purchase of original works and monographs relating to the subjects under investigation. The effort, therefore, has been made to present such an analysis of the labors of others, in connection with the subjects examined, as might prove of value to Students and Practitioners of Medicine, more especially in the Southern States.

The author has had no theories to maintain or destroy, and it has been his constant aim to purify from error the observations which he has recorded.

The inductive method has been followed; diseases have been carefully watched, and traced through their different stages during life, and the vestiges left behind after death have been noted; the actual and relative mortality, under different modes of treatment, and the relations of various diseases to food, habits, occupation, soil and climate, have been observed; and the facts thus gathered, have been interrogated, analyzed, separated and classified; and thus the effort has been made to eliminate or deduce fixed principles in pathology and therapeutics. Whilst facts are true and unalterable, in that they exist, on the other hand, the deductions, or estimate of the value and relations of the facts may be true or false, in accordance with the mode of action of the mind which interprets them; the more thoroughly the mind lays hold of and determines the numerous relations of facts, the nearer does it approach to the demonstration of fixed relations or laws.

The cases reported have been drawn, to a large extent, from hospital and military service, not because the experience gathered in private practice has been either less in amount or value, but because in the Camp, and in the Civil and Military Hospital, it has been possible to keep the patients more thoroughly under observation and control, and in fatal cases, to command the necessary post-mortem examinations.

In the hot and almost tropical climate of the Southern States, it has been necessary, in the prosecution of investigations designed to illustrate the nature, causes, relations and treatment of endemic and epidemic diseases, to encounter the hostile malaria of volume of my labors, conducted in accordance with the order issued from the Surgeon General's office, Richmond, Virginia, February 17th, 1863.

Since the reception of this order, I have devoted all the time not absolutely demanded for the discharge of my duties as Surgeon, to the investigation of the class of diseases indicated; and this volume contains a portion of the results of my labors. In the prosecution of these investigations, the Inductive Method has been followed; the phenomena and individual facts have been observed and recorded, and general principles established by the analysis, comparison, classification, and combination of the facts and phenomena.

If the Surgeon General will furnish an order sufficiently definite and liberal, the present report will be preliminary to a more extended investigation of disease in the different divisions of the Army of the Confederate States of America, by which we hope to establish facts and principles of universal application, and permanent value. By such an extended study of the diseases of armies under all the variations of climate and soil, and under all the varied circumstances of toil, exposure and changes of diet, to which the confederate soldiers are subject, we may hope to settle definitely their true characters and modes of treatment.

From the complicated nature of the phenomena demanding investigation, as well as from the peculiarities of the struggle in which we are now engaged with a powerful enemy, who has blockaded our ports, and thus cut us off from implements and materials of research so valuable in modern inquiries in all the departments of physical, chemical, physiological, and pathological science, many embarrassments have arisen, and will continue to arise, and great expenditures of health and strengh, have been, and will continue to be necessary in the prosecution of these investigations which have been conducted by the author in addition to the full discharge of his duties as Surgeon. * * * * *

The cases presented, in the present report, were selected from more than one thousand cases, treated and carefully observed by the author; and, in addition to those treated immediately by himself, in person, several hundred additional cases were examined in the various hospitals and camps of the Military Department of Georgia and South Carolina, and conferences held with the surgeons and other medical officers.

The attention of the Surgeon General is respectfully directed to the colored drawing of the liver, intestines, and typhoid deposit in the so-called Camp Fever.

It is of the utmost importance to the accuracy and value of these investigations, that the post-mortem examinations should be extended as far as possible. * * *

I would still farther direct the attention of the Surgeon General, to the important fact established by these researches, that the disease which has proved most fatal to our soldiers in the Military District of Georgia and South Carolina, has been Typhoid Fever, and that no case of true Typhus Fever has occurred in this department.

* * * * * *

The importance of this fact, cannot be over-estimated in its bearings on treatment. * *

As the treatment of Typhus and Typhoid fever is different, purgatives being borne well in the former, whilst they are destructive in the latter, it is of great moment to our Army, that Typhus fever should be recognized and investigated.

* * * * * *

The perfection of such investigations will clearly depend in great measure, on the number of cases subjected to analysis. It is well known that fevers arising from animal exhalations are dependent on certain circumstances and causes, which are far more limited in their operation than those producing the various kinds of climatic fevers. As therefore the class of diseases indicated in the order of the Surgeon General, are necessarily circumscribed within narrow limits, and dependent upon peculiar circumstances and causes, their full and free investigation will necessitate occasional change on the part of the investigator. The true characters of these diseases, as well as the great fact of their uniformity or diversity, of their contagion or non-contagion, of their relations to climate and soil, as well as the circumstances most favorable to their production or spread, can only be determined by an examination of their various phenomena in different localities, and by the careful experience and testimony of numerous intelligent observers widely separated.

* * * * * *

During the past seven years I have been conducting investigations similar to those now indicated, upon the diseases of the climate of the Southern States, and have endeavored not only to determine their true characters, and to illustrate their phenomena, but also to investigate their relations to climate, soil and waters, and their relations to well-known poisons; at the commencement of our present struggle I volunteered my services as a Private of Cavalry; my medical services were immediately required after my enlistment, and during a period of six months active service, I was enabled to treat about six hundred cases of disease in one of the most unhealthy regions of the Southern Confederacy; and after entering the medical service as a Surgeon, I have been engaged up to the present time in the investigation of the class of diseases indicated in the Surgeon General's order; the views therefore which I now present in the accompanying manuscript volume, are the results of much labor.

In conclusion, allow me to express my high appreciation of the honor conferred, and to testify my urgent desire to fulfil the high and responsible trust, by every means in my power.

Very respectfully, your obedient servant,
JOSEPH JONES,
Surgeon P. A. C. S.

CONFEDERATE STATES OF AMERICA,
WAR DEPARTMENT, SURGEON GENERAL'S OFFICE,
Richmond, Virginia, July 15th, 1863.

SURGEON JOSEPH JONES,

SIR: Your letter of 2d inst., is received, and also the 1st volume of your "Report on Tetanus and Typhoid Fever."

The pressing importance of a vast variety of official engagements, has so far permitted only a brief and desultory investigation of the contents of the latter; but even with this, evidences enough are discovered, to justify the belief that much very valuable acquisition to the science and art of medicine is contained therein.

For the zeal, untiring energy, patient and laborious industry therein displayed, you are entitled to, and are hereby tendered the thanks of this department.

* * * * * *

It would be well to visit the Hospitals in this department, (Virginia) at once; although it is believed they offer, at the present time, but slight material on which to found a theory, in connection with these investigations, still you might come and see for yourself.

* * * * * *

Very respectfully, your obedient servant,
S. P. MOORE,
Surgeon General, C. S. A.

SURGEON GENERAL'S OFFICE,
August 12th, 1863.

The Surgeons in charge of the General Hospitals in Virginia, will give every facility to Surgeon Jones, to carry out the within instructions.

S. P. MOORE, *Surgeon General.*

RICHMOND, VIRGINIA,
August 6th, 1864.

S. P. MOORE,
Surgeon General C. S. A., War Department, Richmond, Va.:

SIR:—I have the honor to deliver to the Surgeon General, the Third Report on Typhoid Fever, prepared in accordance with the order of September, 1863.

As the Report contains matter of importance to the enemies of the Confederate Government, and as communication with Richmond has been seriously threatened, and even interrupted by the Federal Forces, I deemed it to be my duty to deliver this Report, in person, to the Surgeon General.

The attention of the Surgeon General is respectfully directed to the following facts, developed by the labors recorded in the present volume,

During 19 months, January, 1862 to July, 1863, the number of deaths from all causes, recorded on the Field Reports, which relate to an average force of 160,231 officers and men, was 17,300; or 10.79 per cent. of the entire force. During the same period of time, the deaths recorded in the General Hospitals, numbered 17,059; or 4.2 per cent. of the entire number of cases treated. If we assume that the preceding forces represented only two-fifths ($\frac{2}{5}$ths) of the actual number of men in the service of the Confederate States during this period, then the deaths in the field during these 19 months amounted to 43,250; and if we assume that the Hospital Records during this period, embrace two-thirds ($\frac{2}{3}$ds) of the actual number of sick and wounded, then the deaths in the General Hospitals connected with all the Confederate Forces, would equal 25,588. According to this calculation the total deaths from all causes, in the Confederate Armies, during 19 months, Jan'y 1862 to July, 1863, were 68,838.

If we consider the Hospital Records as imperfect as the Field Records, then the total number of deaths would reach 85,897.

After careful calculation, we have determined that it would be just to assume, that at least 25 per cent. of these deaths were caused by Typhoid Fever; that is, this disease caused during 19 months, in the Confederate Forces, between 17,209 and 21,474 deaths.

It would be fair to assume, that Pneumonia and Typhoid Fever, together, have caused near 50 per cent.; or between 34,419 and 42,948 deaths, in the Confederate Armies during 19 months, January, 1862 to July, 1863.

The great mortality of Typhoid Fever and Pneumonia, amongst the Confederate Forces, invests these diseases with peculiar interest and importance, and should lead to a *thorough examination of the different modes* of treatment now before the Profession. Each medical officer should, as far as possible, test the value of the different modes of treatment, and carefully record the results. The Surgeon General will find in the present volume, 3d Chapter, pp. 457–514, a careful comparison of the results of the different modes of treating Pneumonia, in European and Confederate Hospitals. The mortality from this disease, in a large number of the Confederate Hospitals has been far greater, than what has occurred in this disease, under different modes of treatment in European Hospitals.

In many of the Confederate Hospitals, the mortality from Pneumonia has been twice as great as that in European Hospitals under Tartar Emetic, in large doses, and about four times as great, as under the dietetic and and expectant systems, in which the powers of nature are simply supported and drugs abandoned.

Extended researches have been conducted on Hospital Gangrene, Malarial Fever, Pyæmia and Spurious Vaccination, and upon the relations and classification of fevers, and materials are now in my possession, which will be elaborated and prepared, and delivered to the Surgeon General at the earliest possible moment.

In the manual labor of copying the present Report, I have received valuable assistance from Mr. Louis Manigault, of Charleston, S. C., and I respectfully request the Surgeon General to confirm his appointment as my Secretary.

Very respectfully, your obedient servant.

JOSEPH JONES,

Surgeon P. A. C. S.

CONFEDERATE STATES OF AMERICA.
SURGEON GENERAL'S OFFICE, WAR DEPARTMENT,
Richmond, Virginia, August 6th, 1874.

Surgeon Joseph Jones is directed to institute an extended investigation upon the Causes, Pathology and Treatment of Fevers, and the Relations of Climate and Soil to Disease. Surgeon Joseph Jones will visit those parts of the Confederate States, and prosecute his investigations in those Cities, Armies and Regimental and General Hospitals, which he may deem necessary, as affording suitable fields for the establishment of the results indicated in this order. Medical Directors of the Field and Hospital, and Chief Surgeons of Corps, Divisions, Districts and Brigades, and Surgeons and Assistant Surgeons of Regiments and General Hospitals, will afford every facility to Surgeon Jones to carry out these instructions, and will respond as far as possible to his inquiries by letter and circular, and will furnish him with copies of all Field and Hospital Reports, which he may deem necessary for the illustration of the various subjects of inquiry indicated in this order.

Officers of the Engineer Department are respectfully requested to furnish Surgeon Jones with the necessary facilities for the examination and copying of such Maps, as illustrate the Topography of important Posts and Districts occupied by the Confederate Forces.

Surgeon Jones will embody the results of his labors relating to the diseases of the Confederate Army in suitable volumes, and will deposit them in the Surgeon General's Office, for the use of the Medical Department of the Confederate Army.

S. P. MOORE, *Surgeon General C. S. A.*

The surrender to the United States Forces April 27th, 1865, by General Joseph E. Johnston, of the Confederate Forces under his command, and of the country east of the Chattahoochee, necessarily terminated the labors embraced in the preceding order.

At the time of the evacuation of, and destruction by fire of the government buildings in Richmond, Virginia, the manuscript volumes, containing about 1500 pages, prepared by the author, were captured or burned.

Since the close of the war, the author has endeavored as time and occasion offered, to reproduce those portions of his labors, which appeared to be of chief interest to the Medical Profession of America, and some portions of these labors which have been brought to such a stage of completion as might admit of general conclusions, will be found in the present series of the Medical and Surgical Memoirs.

JOSEPH JONES, M. D.

No. 405 St. Charles Street,
corner of St. Andrew.

NEW ORLEANS, LA., *December*, 1875.

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HISTORICAL NOTES RELATING TO THE ANATOMY AND PHYSIOLOGY OF THE NERVOUS SYSTEM.

It would be a matter of much interest to trace the mode in which the human mind, in the earliest periods of science, gradually distinguished between the nerves and muscles, and unfolded the doctrines of physical, vital, nervous and intellectual forces; but as the learning of the Ancient Egyptians who were amongst the first and most successful cultivators of Medicine, and the first great teachers of the theory and practice, was lost at an early date, such an inquiry can proceed but little beyond the age of Hippocrates.

Homer who described the wounds inflicted in battle, does not employ the word muscle; and even Hippocrates, is held to have had no correct conception of the difference between the nervous and muscular systems. For muscle, Hippocrates employs the word flesh, and he uses indiscriminately the same terms, for nerves, sinews and ligaments, and he asserted that the nerves contract the limbs. Hippocrates, in his book, "*de Insania.*" observes, that man is sane, whose brain is undisturbed, although in another work, referred however, by commentators to the spurious works, he places the mind of man in the left ventricle of the heart.

Pythagoras, considered the Universe as a unit, animated by Divine intelligences, each according to its perfections, occupying its proper sphere: absolute unity or God, according to his system, was considered the spiritual soul of the Universe—the essence of being—the light of lights; between the Supreme Being and man, an incalculable chain of intermediate beings was conceived, whose perfections or attributes were decreased in proportion to their separation from the creative principle. Everything that appeared to have an existence proper, was supposed to proceed from the union of modalities. Thus, the Universe, the grand whole or *macrocosm*, included three secondary worlds; and Man the little world, or *microcosm*, was composed of a body, soul and spirit. manifested by three distinct faculties, viz: sensibility. thought, and intelligence. Man is the point of union between divinity and matter. connecting heaven and earth; the light of wisdom and intelligence that beams in his thoughts. is reflected on nature, and he is the bond of communication between all things. Pythagoras taught, that the soul has a body, which is given to it in accordance to its good or bad nature, by the interior labor of the faculties: he called this body the subtle car of the soul and said that the mortal body is only a gross envelope. Whilst Pythagoras, admitted eternal, uncreated essences, namely: spirit and matter; and explained by the agency of these two principles, the various phenomena of sensibility, intelligence and thought, it is not known that he connected the exercise of the intelligence in man with the Brain or nervous system, or with any special portion of the human body.

Plato the preceptor of Aristotle recognized three distinct faculties of the mind, having three distinct seats, viz, the concupiscent whose seat was in the liver; the irascible, seated in the heart, and the rational seated in the brain. In this doctrine he was followed by Galen. Vesalius, Fernelius, and others, who acknowledged three spirits: the natural which pass from the liver with the blood; the vital, which are carried from the heart to every part of the body, through the arteries: and the animal which are transmitted from the brain. through the whole body by means of the nerves. Plato appears to have held the doctrine that the intellect, was distinct from the material body and capable of exercising itself, without any intervention of the senses. Thus he says in the Phædon:

> "Is anything more rational than to think by the thoughts alone, disengaged from all foreign or sensible agency; to apply at once the pure essence of thought in itself, to the research of the pure essence of each thing in itself, without the ministry of the eyes and ears, without, in short, any intervention of the body, whose slightest influence only troubles the soul and prevents it finding wisdom and truth. If we are ever to attain the knowledge of the essence of things, must it not be in this manner."

Plato held with Anaxagoras, that mind or intelligence is the first cause of all things, and is the regulator and principle of all things.

Plato in common with Pythagoras, held the existence of different orders of created spirits. He says that:

> "The Supreme Intelligence charged the secondary gods with the formation of mortal animals. These gods having received from the hands of the celestial Father the immaterial principle of the human soul, fashioned a body for it, with the most regular and polished of the primitive triangles. This luminous and incorruptible body, which envelopes the immaterial soul, was placed in the brain of man. The gods also endowed, the visible and gross body of the animal with another, mortal soul, the seat of the violent and fatal passions. This occupied the length of the spinal marrow, leaving between it and the divine soul the interval of the neck for fear that the two substances, of a nature so different, being too closely connected, the least pure, might tarnish or embarrass the other by its contact.
>
> "Therefore the gods placed the mortal soul in the chest and trunk; and as this soul contains a good and a bad principle, they divided the cavity of the trunk into two departments, just as is done with the apartments of males and femals, by means of the diaphragm, placed in the middle as a partition. Nearer the head between the diaphragm and the neck, they placed the manly and courageous, or bellicose principle of the soul; so that being submitted to, and in concert with the reason, it may restrain the revolts of the passions and desires, when these are unwilling to be controlled by the influences which reason sends down from its citadel.
>
> "That portion of the soul which requires food and drink, and all that the nature of our body renders necessary, is located between the diaphragm and the umbilicus. The gods have extended it over this entire region, like a rack, where the body may find its food. They have confined it there, like a ferocious beast, which it is necessary, nevertheless to feed, so that the mortal man may subsist."

Aristotle is credited by some writers, with the discovery of the nerves of sensation, which he is said to have called the canals of the brain: but this great systematic writer and logician attempted no analysis of motion and appeared to have no idea of the true functions of the brain, although he appeared to have been better acquainted with the anatomy of this viscus, than any of his predecessors.

Aristotle, described the brain as an inert viscus, cold and bloodless, an organ *sui generis*, and not to be enumerated amongst the other organs of the body, as it had no use except to cool the heart. Aristotle thus explains how the brain, might be the refrigeratory of the heart:

> "Inasmuch as vapours arise from the waters and earth, and when they reach the cold middle region of the air, are condensed into water, which falling upon the earth cools it, so also the hot spirits carried from the heart to the brain, with the blood, and there being cooled are condensed into water, which again descends to the heart for the purpose of cooling it."

Aristotle placed the seat of the rational soul in the heart, where it can exercise all its functions, and he therefore made the nerves of the use of which in sensation and motion he was not ignorant,) to arise in the heart.

The anatomical and physiological views of Aristotle may be gathered from the following quotations:

> "That which is first found in opening the head, is the brain, and it is placed in the anterior part. All animals possessing a brain, that is to say, all those which have blood, as well as those of the order Mollusca, have it generally placed in the same position; but the brain of man is much more considerable than that of other animals proportionably to the size of his body, and is also the most humid. The brain is enveloped in two membranes; that nearest to the cranium is the strongest—the other, which rests immediately upon it, is weaker. The brain is always composed of two lobes, independently of the cerebellum, which lies beneath, and whose form and structure differ from that of the brain. There is usually a little cavity in the middle of the mass of the brain; its substance is naturally cold to the touch, and neither veins nor blood are ever found in its interior; but the membrane which envelopes it is full of veins.
>
> "Let us speak now of the nerves, they proceed also from the heart, that viscus containing nerves in its structure—in its largest cavities; and what is termed the Aorta is a nervous vein, whose extremities are nothing else than nerves. At the points where those extremeties terminate around the joints of bones, they are not hollow, and are susceptible of the same tension as the active nerves. But the difference between the nerves and the veins is, that the nerves do only proceed without interruption from one unique substance to all parts of the body, like the veins. The nerves on the contrary, are distributed on all sides, and to the articulation of the bones. If they proceed from the same trunk, their continuity would be apparent in emaciated animals.
>
> The principle nerves are those of the brain, on which depend the power of leaping, then another double nerve-called the tendon; then the extensor and the nerve of the shoulder, which contribute to the strength of the body. No particular name is given to the nerves, which belong to the articulations, because all articulations of the bones, are bound together by the nerves. In general, the nerves are found in great abundance around the bones, except the bones of the head which are united by sutures."

It is evident from the preceding quotations, that Aristotle had no distinct notion of the locomotive apparatus; that he confounded the tendons and ligaments with the nerves, that he placed the seat of the soul and sensation in the heart, and that he had no conception of the elevated functions of the encephalic organ.

Herophilus of the Alexandrian School, who lived in Egypt, in the time of the first Ptolemy, distinguished nerves as the organ of the will, and the channels of perception. He maintained, that the Calamus Scriptorius, (the ventricle of the cerebellum,) is the chief of all the ventricles of the brain, and that the nerves of volition spring from the brain and medulla spinalis. Erasistratus, however, before Herophilus, taught when young, that the sensory nerves arise from the meninges, and the motor from the cerebellum; but when old, he taught that both classes of nerves arise from the medullary matter of the brain; and that the animal spirit was from the head, and the vital from the heart.

It appears according to the most certain traditions, that Erasistratus and Herophilus were the first, after the nervous system had been recognized as the ultimate organ of the animal and vital functions, and the brain ascertained to be its centre, who appropriated to different parts of that organism, the functions of sensation and voluntary motion. Rufus, the Ephesian, who lived under Trajan, says that Herophilus distinguished three sorts of nerves; the first which serve for sensation and voluntary movements, proceed from the brain and spinal marrow as ranucles; the second and third are destined to unite the bones and muscles. Although Herophilus had not entirely shaken off the prejudice which confounded tendons, ligaments and membranes with the nerves, nevertheless his doctrine was a decided advance upon that of Hippocrates, Aristotle and the Asclepiadaæ.

Erasistratus placed the source of sensation in the meninges or membranes, and of voluntary motion in the substance of the brain, the nerves being mediately, or immediately the prolongations of these membranes. According to this theory, then, the nervous membranes were the vehicle of sensation, and the nervous substance the vehicle of motion. If we may credit Rufus, Erasistratus did not derive the nerves from the membranes of the Encephalon to the exclusion of its substance. This theory, which manifests the tendency, from an early period, to refer the phenomenon of motion and sensation to distinct parts of the nervous organism, was again advanced by Fernelius, in 1550, by Rosetti, in 1722, and by LeCat, in 1740, and by each of these authors the hypothesis was regarded as original.

As early, therefore, as the days of Erasistratus, there was apparently the commencement of that long series of observations which ended in the important discovery of Sir Charles Bell, that the spinal nerves are the organs of motion, through their anterior roots, and of sensation through their posterior; and the recognition, by physiologists, that each ultimate nervous filament is distinct in function, and runs isolated from its origin to its termination.

It appears, also, that Erasistratus anticipated also many recent physiologists, in the doctrine that the intelligence of man, and of animals in general, is always in proportion to the depth and number of the cerebral convolations; that is, in the ratio of the extent of cerebral surface, not of cerebral mass.

Those cases of nervous disease, in which either motion or sensation were exclusively lost, as well as those cases of paralysis in which both motion and sensation and intelligence were lost, must, without doubt, have attracted attention at an early period in the history of medicine, and at the same time necessitated the conclusion that sensation and motion are either the functions of different organs, or, if the same, that they were at least regulated by different conditions. Between these alternatives, all opinions on the subject of nervous action have been divided, and, as we have seen from the preceding examination of the views of Erasistratus, the conclusion that sensation and motion are the functions of different portions of the nervous system, was the first, as it has been the last to be adopted.

Galen expressed in his writings many clear and sound views with reference to the animal mechanism; he compared the office of the skeleton to that of the poles of a tent, or the walls of a house; he demonstrated, by actual experiments, the action of various muscles, and his views as to the action of the muscles, were not only anatomically and mechanically correct, but his discoveries and descriptions even of very minute parts of the muscular system have been regarded with favor by modern anatomists. He proved experimentally, by sections of the nerves, the dependence of all musular motion upon the nerves, which, according to his view, all originated in the brain. Galen says that in his time it was allowed by all, both philosophers and physicians, that where the origin of nerve is, there the seat of the soul must be; and this, he adds, is in the brain, and not in the heart; although he is not always consistent in the shares which he assigns to the heart and to the brain, in the elaboration of the animal spirits, nor is he uniform in maintaining a discrimination of origin between the animal spirits and the vital, holding, with Plato and Aristotle, that the human soul is composed of three faculties, or rather, of three parts; the vegetative, which resides in the liver, the irascible, which has its seat in the heart, and the rational, which dwells in the brain. The fact that when the brain of the living animal is uncovered by removing a portion of the vault of the cranium, that viscus is seen rising and falling alternately, did not escape Galen, who compared it to the pulmonary respiration, and attributed it to the same cause. He held that the brain expanded like the lungs, to draw in the air, and contracted to expel it; the atmospheric fluid penetrates the cavity of the cranium through the cribriform plate of the ethmoid bone, and passes out by the same vent, carrying with it the excrementitial humors of the brain, which run into the nasal fossæ; nevertheless the air introduced into the cephalic cavity, by inspiration, is not entirely rejected by expiration. A portion insinuates itself into the anterior ventricles of the brain, and unites with the vital spirits, which are carried there by the arterioles of the choroid plexus; from this combination originate the animal spirits, the immediate agents of the rational soul, and the most subtle of all the spirits; these acquire their last attenuation in the fourth ventricle, where they are instilled drop by drop, through a round, narrow vermiform tube (acqueduct of sylvius); then the animal spirits are transferred into the substance even of the brain, little brain and spinal marrow, where they are kept in reserve to be distributed by the agency of the nerves to all parts of the body, and they give to each region according to the direction and wants of the animal faculty, sensation, motion and energy.

In opposition to Aristotle, who supposed the nerves to originate at the heart, Galen stated that all the nerves are derived from the brain and spinal marrow. He enumerated seven pairs of cerebral nerves, which comprise all that are admitted now, except the sympathetic, and the external motor of the orbit; thirty pairs of spinal nerves, which he divides as follows: Eight cervical, twelve dorsal, five lumbar, and five sacral. Galen pointed out two sorts of nerves, one of which, those of sensation, he described as soft, and proceeding from the brain, the other set, the nerves of motion, as harder, and originating in the spinal marrow.

Whilst Galen recognized, as others had done before him, the contrast of the two phenomena of sensibility and motion, and actually designated distinct nerves of sensation and motion, he was ignorant of the fact, that each nerve by its double origin on the anterior and posterior parts of the spinal marrow, contained both sensory and motor filaments. Considering the membranes as mere envelopes, Galen limited the peculiar functions of the nervous system, to the enveloped substance of the cerebrum, cerebellum, spinal cord and nerves; but as the animal faculty, according to his view is one, and its proximate vehicle, the animal spirits, is homogeneous, and as the nervous, or cerebral substance, which conducts these spirits, is in its own nature uniform and indifferently competent to either function, it therefore depended, according to this theory, upon two accidental circumstances, whether this substance conduce to sensation, or to motion and sensation together.

The ganglions of the nervous system were well known to Galen, and he claimed their discovery, and he appears to have had some notions of the great sympathetic; and so marvelous was his minute knowledge of the distribution and functions of the several nerves, that it has been asserted by competent authority, that, with the exception of a few minor particulars, his pathological anatomy of the nervous system was practically on a level with the pathological anatomy of the early part of the nineteenth century.

The next important advance was made in the middle of the fourteenth century, after Galen's death, by Roundeletius in 1550, who, reasoning from the phenomena of paralysis and stupor, announced it as an observation not previously made, that all nerves, from their origin in the brain, are even in the spinal marrow itself, isolated from each other. The cause of paralysis is, therefore, not so much to be sought for in the spinal marrow as in the encephalic heads of the nerves; Galen himself having remarked that paralysis always supervenes when the origin of the nerve is obstructed or diseased. Laurentius, of Montpellier, a celebrated professor in the same university with Rondeletius, some thirty years later (1595), advanced the same doctrine, as a new and hitherto unheard of observation. This anatomist and physiologist first attempted a sensible demonstration of the fact, by resolving under water, the spinal chord into its constituent filaments. He affirmed that this observation explained one of the obscurest problems of nature, viz: Why it is that from a lesion, say of the cervical medulla, the motion of the thigh may be lost, while the motions of the arms and thorax shall remain entire. Laurentius, however, did not rise above the Galenic doctrine, that sensibility and motion may be transmitted by the same fibre; and, in fact, rejecting the discrimination of hard and soft nerves, he abolishes even the accidental distinction that had been recognized by Galen.

Another important step in the anatomy of the cerebro-spinal nervous system, was accomplished by Varollius in 1572, when he showed that Galen was mistaken, in holding that the spinal chord is a continuation of the cerebellum alone. Varollius demonstrated that this chord is made up of four columns, severally arising from four encephalic roots; two roots or trunks from the brain proper, being prolonged into its anterior, and two from the cerebellum into the posterior columns.

Contemporary anatomists (as Coiter, 1572, and Laurentius, 1595), recorded the fact, that the spinal nerves arise by double roots, one set of filaments emerging from the anterior, another from the posterior portion ef the chord. It was noticed also by Coiter, and Bauhinus (1590), and others, that these filaments, in issuing from the spinal chord, passed into a knot or ganglion; but it was reserved for the second Monro, (1783), nearly two centuries afterwards, to record the important observation, that the ganglion is limited to the fibres of the posterior root alone.

The anatomists of the sixteenth century, described with more exactness than Galen, the various branches of the nervous system. They distinguished more clearly each part, followed farther the distribution of vessels and nerves, and corrected some material errors in this branch of anatomy, which had existed from the time of Galen. Whilst they assured themselves that the nerves of the cerebrum, cerebellum and spinal marrow, served equally for sensation and motion; nevertheless, they still held most of the ancient prejudices concerning the organs of sensibility and mobility, as well as the manner in which they executed their functions. It now seems almost marvellous, that, while the anatomists of the sixteenth century were acquainted with the important facts of the independence of the motory and sensitive functions, that of these functions the cerebral nerves were in general limited to one, while the spinal nerves were competent to both; that the spinal nerves, the nerves of double function, emerged by double roots, and terminated in a two-fold distribution, and that each nervous filament ran distinct from its peripheral extremity through the spinal chord to its origin, should have stopped short of further inquiry and experimental demonstration, and should not have surmised that in the spinal nerves difference of roots corresponds with difference of function, and anticipated by actual demonstration, and by two centuries the most important physiological discovery of the nineteenth century.

Galen described in succession seven pairs of nerves, making the optic nerves the first pair; the second those distributed to the muscles of the eyes, and the third and fourth pairs those distributed to the tongue and palate. Marinus is said to have established this division of the cranial nerves into seven pairs, which Vesalius found to be incomplete; but Willis, in 1664, established the classification of the cranial nerves at present recognized. Willis described the olfactory nerves as the first pair, which previous to him were not recognized as a pair, and he added the sixth and ninth pairs, which former anatomists had not recorded, and he was the first to describe in a distinct manner the "*Nervous Centre*," the pyramidal eminences which connect the brain with the spinal marrow. The earlier anatomists examined the brain only by slicing, so as to obtain sections, but Varolius endeavored to unravel its parts, and in this important method of investigation, he was followed by Willis, and more recently by Vieussens and Gall. Thomas Willis advanced new hypotheses as to the uses of the nervous system,-but with these he commingled certain ancient doctrines, as for example, that serous effete matter, in the ventricles, trickles partly through the olfactory nerves into the nostrils, partly through the infundibulum to the pituitary gland, and thence by peculiar ducts to the veins, which return the blood to the heart from the brain. Willis also agreed with Galen in regarding the use of the fornix to consist in supporting the hemispheres. The peculiar doctrines of Willis were that the cerebrum subserves the animal functions and the voluntary motions, the cerebellum subserves the involuntary motions; that a perception of all the sensations, takes place in the ascending fibres of the corpora striata, and that through the descending, voluntary movements are excited; that the understanding is seated in the corpus callosum, and memory in the convolutions, which are its storehouses; that the animal spirits are generated in the cortex of the cerebrum and cerebellum from the arterial blood, that they collect in the medulla are variously distributed and arranged to excite the animal actions and distill through the fornix; that the animal spirits secreted in the cerebellum are ever flowing, equally and continuously into the nerves which regulate involuntary movements; but those of the cerebrum tumultuously and irregularly according as the animal actions are vehemently performed or quiescent. To excite sensation, the spirits flow along the nerves to the brain. Willis distinguished between a thick nervous fluid, suitable to nutrition, and the extremely volatile animal spirits, subservient to sensation and movement. He explained the unity of the nervous actions, by the communications or anastomosis of the nerves; and he also held that the union of the cerebrum and cerebellum is attained by the tubercula quadrigemina, or nates and testes. As to the loops of the nerves, with which the arteries are here and there encircled, he states their use to be to relax and close the arteries, and thus during various emotions of the mind, to admit the blood in greater or less quantity to certain parts. He decided that the pineal gland is not the seat of the soul, but a lymphatic gland, having no relation with the substance of the brain, which absorbs lymph and carries it off again, through another vessel, and keeps the plexus choroides expanded.

Glisson, of the Univerity of Cambridge, in 1672, distinguished muscular irritability as a peculiar power of the fibres of muscles, pointed out the differences of irritability in different organs, and divided irritation into natural, vital and animal. In his attempts to explain the mode in which the nerves operate on the irritability, Glisson assumed the existence of certain mild, sweet fluids or vital spirits, which resided in the nerves; the existence of a peculiar nervous spirit like air, had been previously maintained by Erasistratus, Asclepiades, Galen and others, and this theory found its most phiosophical expression in the doctrine of an ether or thin, elastic fluid, pervading all space, the vibrations of which give rise to the phenomena of heat, light and nervous force. Thus Newton asks: "Is not vision performed chiefly by the vibrations of this medium excited in the bottom of the eye, by the rays of light, and propagated through the solid, pellucid and uniform capillamenta of the nerves into the place of sensation? Is not animal motion, performed by the vibrations of this medium, excited in the brain by the power of the will, and propagated from thence through the capillamenta of the nerves into the muscles for contracting and dilating them?" Haller also conceived that the nervous spirit which was too fine to be perceived by the sense, was more gross than fire, magnetism and electricity, as it was contained in vessels and confined by boundaries.

The successors of Willis, especially of the school of Leyden (the school of Boerhaave and his disciples), embraced some of his doctrines, whilst others were abandoned or exploded. For example, it was shown by anatomy, that all the nerves are not of involuntary motion, which arise from the cerebellum, as the fifth pair of cerebral nerves, is wholly derived from the medulla of the cerebellum, the pons varolii.

Boerhaave held, with Willis, that the cerebrum is the organ of animality, a distinct part thereof being subservient to each of its own functions, sense and voluntary motion; that the cerebellum is the organ of vitality, or of the involuntary motions; and that the cerebrum and cerebellum are prolonged, the former into the anterior, and the latter into the posterior columns of the spinal chord. Boerhaave held that all nerves are composite, being made up of fibrils, of a tenuity, not only beyond our means of observation, but almost beyond the capacity of the imagination. Some nerves are homogeneous, their constituent filaments being either for a certain kind of motion alone, or for a certain kind of sensation alone; others are heterogeneous, their constituent fibrils being, some for motion others for sensation; and of this latter class are the nerves which arise from the spine. According to the doctrine of Boerhaave, however, the spinal nerves, in so far as they arise from the anterior column, are nerves both of sensation and voluntary motion (of animality); in so far as they arise from the posterior column, are nerves of involuntary motion (of vitality). A homogeneous nerve does not, as a totality, perform a single office; for every elementary fibril of which it is composed, runs, from first to last, isolated from every other, and has its separate sphere of exercise; each distinct sphere of sensation and motion, has so many distinct nerves and terminations, and all the different points of local termination in the body have corresponding points of local origin in the brain. The centre of motion and sensation (the sensorium commune), therefore, is not an indivisible point, nor even an undivided space, but, on the contrary, it is the aggregate of as many nervous terminations as there are encephalic origins of nervous fibrils. As no nerve, therefore, gives off a branch, their sheaths of dura-mater alone ramifying, there is no sympathy between the elementary fibrils, except through the sensorium commune.

Van Swieten adopted, but did not advance the doctrine of Boerhaave, and Haller abandoned the opinion that sensation and motion are conveyed by different nervous fibrils. Haller considered it to be a most improbable conjecture, that the same nerve may contain within its sheath, both motory and sensitive tubules, distinct in their origin, transit and distribution, but which, at their peripheral exremity communicated; the latter, like veins, conveying the spirits to the brain, which the former, like arteries, have carried out

The doctrine of the school of Leyden on this point was, however, still more articulately evolved by the younger (Bernard Seigfried) *Albinus;* not in any of his published works, but in the prelections he delivered for many years in that university, on physiology. From a copy in the possession of Sir William Hamilton, of the dicta of Albinus in this course, very fully taken, after the middle of the eighteenth century, by Dr. William Grant, compared with another very accurate copy of the dicta, taken by an anonymous writer, in the year 1741, Sir

William Hamilton was enabled to present the following abstract of the doctrine taught by this celebrated anatomist:

> "The nerves have a triple destination, as they minister, (1) to voluntary motion, (2) to sensation, (3) to the vital energies, secretion digestion, etc. Albinus seems to acquiesce in the doctrine that the brain proper is the ultimate organ of the first and second function, the After-Brain of the third.
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> Nerves, again, are of two kinds. They are either such, in which the function of each ultimate fibril remains isolated in function from centre to periphery (the cerebro-spinal nerves), or such in which they are mutually confluent (the ganglionic nerves).
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> To speak only of the cerebro-spinal nerves, and of these only in relation to the functions of motion and sensation; they are to be distinguished into three classes, according as destined: (1) to sense, (2) to motion, (3) to both motion and sensation. Examples of the first class are the olfactory, the optic, the auditory, of which last he considers the portio mollis and the portio-dura to be, in propriety, distinct nerves; of the second class, are the large portion of those passing to muscles, as the fourth and seventh pairs; of the third class are the three lingual nerves especially, the ninth pair, fibrils of which he had frequently traced, partly to the muscles, partly to the gustalory papillæ of the tongue, and the subcutaneous nerves, which are seen to give off branches, first to the muscles, and thereafter to the tactile papillæ of the skin. The nervous fibres which minister to motion, are distinct in origin, in transit, in termination, from those which minister to sensation. This is manifest in the case of those nerves which run from their origin in separate sheaths, either to an organ of sense (as the olfactory and optic), or to an organ of motion (as the fourth and sixth pairs, which go to the muscles of the eye); but it is equally, though not so obtrusively true in the case where a nerve gives off branches, partly to muscles, partly to the cutaneous papillæ. In this latter case, the nervous fibrils or fistulæ are, from their origin in the medulla oblongata, to their final termination in the skin, perfectly distinct. The medulla oblongata is a continuation of the encephalos, made up of two columns, from the After-Brain. Immediately or mediately it is the origin, as it is the organ of all the nerves. As in both respects it is double, for one part, the organ of sense affords an origin to the sensitive fibrils; whilst another, the organ of motion, does the same by the motory. In their progress, indeed, after passing out, the several fibrils, whether homogeneous or not, are so conjoined by the investing membranes, as to exhibit the appearance of a single nerve; but when they approach their destination they separate, those for motion ramifying through the muscles, those for sensation going to the cutaneous papillæ or other organs of sense. Examples of this are afforded in the ninth pair, the fibres of which (against more modern anatomists), he holds to arise, by a double origin in the medulla, and which, after running in the same sheaths, separate according to their different functions and destinations; and in the seventh pairs, the hard and soft portions of which are respectively for motion and for sensation, though these portions, he elsewhere maintains, ought rather to be considered as two distinct nerves, than as the two-fold constituents of one.
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> The proof of this is of various kinds. In the first place, it is a theory forced upon us by the phenomena; for only on this supposition can we account for the following facts: (1). That we have distinct sensations transmitted to the brain from different parts of the same sensitive organ (as the tongue) through which the same total nerve is diffused. (2). That we can send out from the brain a motive influence to one,—nay, sometimes to a part of one muscle out of a plurality among which the same total nerve (e. g. the ischiatic) is distributed. (3). That sometimes a part is either on the one hand paralysed without any loss of sensibility, or on the other, stupified without a dimunition of its mobility.
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> In the *second* place, we can demonstrate the doctrine, proceeding from centre to periphery, and from periphery to centre. Though ultimately dividing into filaments beyond our means of observation, we can still go far, in following out a nerve, both in its general ramifications, and in the special distribution of its filaments, for motion, to the muscles, and for sensation to the skin, etc.; and how far-so-ever we are able to carry out our investigation, we always find the least fibrils into which we succeed in analyzing a nerve, equally distinct and continuous as the chord of which they were constituent. And again, in following back the filaments of motion from the muscles, the filaments of sensation from the skin, we find them ever collected into larger and smaller bundles, within the same sheath, but never losing their individuality, never fused together to form the substance of a large chord. The nerves are thus not analogous to arteries, which rise from a common trunk, convey a common fluid, divide into branches all similar in action to each other, and to the primary trunk. For every larger nerve is only a complement of smaller nerves, and every smallest nerve is only a fasiculous of nervous fibrils; and these, not only numerically different, but often differing from each other in the character of their functions.
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> "In the *third* place, that in the nerves for both motion and sensation, are enveloped distinct nerves or fibrils for their several functions—this is an inference, supported by the analogy of those nerves which are motive or sensitive exclusively. And in regard to these latter, it becomes impossible, in some cases, to conceive why a plurality of nerves should have been found necessary, as in the case of the two portions of the seventh pair, in reality distinct nerves, if we admit the supposition that each nerve, each nervous fibril is competent to the double office.
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> "In the *fourth* place, the two species of nerve are distinguished by a difference of structure. For he maintains the old Galenic doctrine, that the nerves of motion are as compared with those of sensation, of a harder and more fibrous texture;—a diversity which he does not confine to the homogeneous nerves, but extends to the counter filaments of the heterogeneous. This opinion, in modern times, by the majority surrendered rather than refuted, has been also subsequently maintained by a small number of the most accurate anatomists, as Malacarne and Reil; and to this result the recent observations of Ehrenberg and others seem to tend. (See Memoirs of the Berlin Academy for 1836, p. 695, sq.; Mueller's Phys., p. 598).
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> "Finally, to the objection—Why has nature not, in all cases, as in some, enclosed the motive and sensitive fibrils in distinct sheaths? As answer, and *fifth* argument, he shows, with great ingenuity, that nature does precisely what in the circumstances, always affords the greatest security to both, more especially to the softer fibrils; and he might have added as a sixth reason and second answer, with the smallest expenditure of means.
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> The subtility of the nervous fibres is much greater than is commonly suspected; and there is probably no point of the body to which they are not distributed. What is the nature of their peripheral terminations it is, however, difficult to demonstrate, and the doctrines of Ruysch and Malpighi in this respect are, he shows, unsatisfactory. (The Works of Thomas Reid, D. D.; Notes and Supplementary Dissertations by Sir William Hamilton, Edinburg, 1858, pp. 869–875.")

Marcellus Malpighi, held the ancient opinion of Plato, that the Brain is an appendage to the Spinal Chord, in which medullary fibres collected together radiate towards the brain, until they end in the cortical portion, just as the fibres in the stem of a cauliflower, radiate into the leaves. Fracassatus, also adopted this opinion, and Thomas Batholin, affirmed, that this was both new and peculiar, and that by it he could understand, how fishes, on account of their small brain, are dull as to sensation, but agile as to movement, from their large spinal chord; especially since in the incubated egg also, the anterior part of the brain is developed at a much latter period than that in which if the chick be touched it contracts. It is well known however, that Plato, had already stated that the spinal chord is first formed and the brain is an appendix. Malpighi maintained that the cortical portion, secretes by means of a glandular structure, which he pretends it contains, a coagulable serum, from arterial blood, and that it is necessary to sensation and movement, that this fluid be transmitted from the cortical to the medullary matter. It did not seem possible to him that there could be a reflux of this serum, in the nerves to the brain, so as to cause sensation, since the new serum perpetually secreted, resists the retrograde movement. Ruysch, in opposition to Malpighi, endeavored to prove by his injections, that the cortex of the brain is not glandular, but consists of parallel vessels; but Albinus clearly showed that the cortex of the brain was not altogether vascular.

The doctrine of the Leyden school and especially of Boerhaave and Albinus, in regard to the nervous system, and in particular touching the distinction and isolation of the ultimate nervous filaments, does not seem to have been universally adopted, although in the works of Unzer and Prochaska, similar views were advanced; and it appears strange that Johann Mueller, the most illustrious physiologist of the present century should have claimed as peculiarly his own, the doctrine, "That the primitive fibres of all the cerebro-spinal nerves are to be regarded as isolated and distinct from their origin to their termination, and as radii. issuing from the axis of the nervous system." Mueller, even vindicates his right to this so-called discovery, against other cotemporary observers, by stating that it had been privately communicated by him to Van der Kolk, of Utrecht, so long ago as the year 1830.

John Augustus Unzer, gave to the world, his "Principles of a Physiology of the proper Animal Nature of Animal Organisms," in 1771, at the mature age of 44, and after he had been virtually engaged for a quarter of a century in its preparation. His work therefore has been justly considered, as the product of a powerful metaphysical intellect, in the prime of its strength, and thoroughly informed on the subject to which it had been so long and so perseveringly and so assiduously directed.

It is probable, that his mind was directed to this subject, by his early associations at the University of Halle, were both Hoffmann and Stahl had been professors for lengthened periods. and when Unzer commenced his medical studies, the former was still professor at the venerable age of 79. It was however, as the pupil of Juncker, an avowed Stahlian, that he directed specially his attention to the metaphysics of vital action. At this time physiology, and especially the physiology of the nervous system, was fast losing its purely hypothetical character, and assuming the rank of a science. Mental philosophy had long taken cognizance of the different kinds of motion in animals, of which every man is led to discriminate at least three; namely: 1st, those dependent solely on the will; 2d, those of which he is conscious, but which are independent of the will as the exciting cause; 3d, those of which he is wholly unconscious, and which can neither be excited nor restrained by volition. The first class of actions could be readily ascribed to the soul; but the second and third classes, although independent of reason, volition, and even consciousness, were equally characterized by their intelligent and exact adaptation to the wants of the animal. To explain the origin of these adapted acts, and to determine their relations, to those of the reason and will, was a problem which had occupied and baffled the greatest intellects, from Plato downwards, and a satisfactory solution had never been been given to the world.

During the time that Unzer, was a student, and subsequently, general and histological anatomy and experimental physiology were assiduously cultivated, and every year, some interesting experiment or discovery was made: Lancisci, Valsalva, Pacchioni, Baglivi, Santorini, Morgagni, and Spallanzani flourished in Italy, Winslow and Vicq d'Azyr, in France.—Albinus, in Holland,—Lieberkühn, Haller and Sömmerring, in Germany,—and Cowper Cheselden and the Monros in England; whilst Krüger, Wrisberg, Meckel, Lobstein, Walther, and others, made the structure and functions of the nervous system their special study. The progress of comparative anatomy, and experiments on living animals, during this period, cast vast light on neurology. The vascular organization of the grey substance was known before the close of the last century, and it was no longer a question, that the encephalon was the organ of sensation and voluntary motion, and the seat of the mind. The researches of R. Vieussens, Haller, T. F. Meckel, Vicq. d'Azyr, A. Scarpa, Th. Sömmerring, and of a great number of other physiologists, had put this fact beyond question. They had demonstrated that the dura-mater receives no nerves, and that it is destitute of all sensibility, and could not be the source of any movement. It was shown also by rigorous observation, that all the nerves coincide, and are united at the base of the brain, in that part termed the protuberance annulare, from which it was inferred with some probability, that this was the sensitive centre of the animal—the place where all the sensations centred, and from which go forth all voluntary and reflex actions.

Thus, during the preparation of his great work, new facts were brought before the intellect of Unzer; it is nevertheless true, however, that he lived and wrote far in anticipation of his age and his contemporaries, and that which he established hypothetically, but logically, has since been demonstrated by dissection and experiment, and much that he advanced, remains to be duly appreciated.

Unzer endeavored to distinguish the physical forces, from the vital, nervous and intellectual forces of animals, and if his analysis was defective in some respects, it was necessarily so from the imperfect state of those fundamental branches of knowledge upon which the more restricted and complicated phenomena of living beings, depend for their proper elucidation and development.

The following is a brief outline of the work:

The primary seat of the animal forces, is in the so-called *proper animal* machines, namely, the brain with its animal spirits, together with the nerves, through which the latter are communicated to the mechanical machines.

Animal nature, is the aggregate of the proper animal forces, and the science of these uncomplicated, is the *physiology of animal nature*. All animal forces act, when untrammeled, either necessarily in connection with the mind of the animal or not; and thus the science is divided into two great divisions. The first treats of the animal nature in its connection with mind, that is, in other words, with reference to the *animal sentient forces;* but the second, in reference to the *nerve forces*, independently of the mind; out of these a third division arises, which describes the *animal nature as an independent whole*, compounded of these two animal forces.

The First Part, is devoted exclusively to the *animal sentient forces* of the animal machines, which are considered with reference to their action, in two ways; namely, partly *per se*, as they themselves act in the animal machines—the brain and nerves—and partly in reference to their *influence on the mechanical machines*, with which the nerves are incorporated. In the concluding chapter, the connection of the *conceptive force*, and the animal moving forces, or in other words, of mind and body is set forth.

In the Second Part, the *nerve forces* are treated of, so far as they act independently of the mind. It is shown that, besides, the animal sentient forces of the brain, there are only two kinds of forces of the nerves which act in the body, as animal motive forces, namely, the sense-like impressions, which are divided into internal and external. These two kinds of impressions are considered in the second and third chapters respectively; and in the fourth, their relations to the mental forces are elucidated. Modern physiologists, Haller, Zimmermann, Whytt, and Oeder, had rendered much service to this department of physiology, by contributing materials thereto. Haller, indeed, began to trace out the plan of this new department, which certainly did not exist before him, but there he stopped: Unzer ventured to extend this outline, with the hope of inducing able men to complete it. The most important progress which Unzer accomplished in this matter, consisted of the following: he defined the two kinds of impressions, and the entirely different law by which they move the body without having recourse to the hypothesis of vital spirits, as a motive power; for these sense-like impressions can be considered simply as phenomena, and their laws of action discovered without a knowledge of their nature; and he derived primarily from the nerves, that motive force of the external impression, which Haller assigned to the muscular fibres, under the designation of *irritability*, but denied it to be a property of the nerves; and finally, he demonstrated in advance of Le Gallois, Lobstein, Philip, Sir Charles Bell, and Marshall Hall, the doctrine of reflex action, or the *deflection* and reflection of the impressions in the nerves, whereby Unzer affirmed, that many phenomena of the animal economy, hitherto inexplicable can be understood, and he showed how the *vis-nervosa* is sufficient of itself to develop these movements in bodies, which were formerly attributed to the influence of the mind or soul, and *vice versâ*. Unzer details many facts to show that the spinal cord constitutes a separate centre of nervous influence not necessarily connected with the action of the brain, and he clearly recognized the influence of the nerves over secretion and nutrition, and anticipated by nearly a century the doctrine of the so-called Excito-Secretory functions of the nervous system, the discovery of which has been claimed by physiologists of the present day.

In the Third Part, Unzer describes the economy of animal forces in general, and traces as it were, the course of life in animal nature, classifies the different genera of animals, from the irrational to the rational, and treats of the *origin of life*, *maturity of the animal forces*, *decline and death of animal nature*.

The following quotations, which I have selected from various portions of his work, will illustrate the views of Unzer, with reference to some of the more important questions and doctrines of neuro-physiology and pathology:

"The proper animal machines in animal organisms are the brain and nerves, in which the vital spirits (the nervous fluid), are produced and distributed, with the object of constituting the medium of the functions of these organs.

"*The brain is the seat of the soul.* We feel that we think in the head; nowhere else are we conscious of our existence; in no other organ is there a thought, or an idea or consciousness. Now, since the sentient faculty of animals is their soul, the soul can have its seat nowhere else than in the brain, and it would be absurd to maintain that it is diffused throughout the body. It is sufficient to a physician to know, that the thinking faculty can have no other seat than the medullary matter of the brain.

"*The brain is the laboratory of the vital spirits.* It appears certain that there is such a fluid essence secreted from the vessels of the gray matter of the brain into the hollow tubes of the medullary matter, which is carried into the tubes of the nerves to their termination, and supplies the principle whereby the nerves are rendered capable of being the organs of the senses and of movements. (Haller's Physiology, Sec. 383). As the gray or cortical substance of the brain is the secreting organ of the vital spirits, the medullary substance must be the seat of the animal sentient forces.

"The brain also gives origin to all the nerves, which are continuations of the cortical substance, given off partly from it directly in small bundles, termed the cranial nerves, and partly from a thick cord of it termed the spinal marrow, which passes through the spine, whence the nerves are distributed to all parts of the body.

"The nerves generally are enclosed in an investing membrane, and, like the blood-vessels, divide and sub-divide in the greater part of the body, which they either penetrate or form loops in; or, having lost their investing membrane, are so incorporated with the soft parts, that they can be no longer traced. Their essential element is the medullary matter of the brain, or the soft substance enclosed within the cortical substance of the brain; whereas their investing membrane seems to have no share in the proper animal functions allotted to them. Every nerve is a bundle of much smaller fibrils, each of which runs an independent course to and from the brain. Every nerve has its special point of origin in the brain, and every fibril must have its special origin from that point, from whence it takes an entirely independent and separate course through the medulla oblongata and the spinal cord, to its minutest termination. According to all probability, the fibrils of the nerves are hollow canals.

"The nerves so terminate externally, that either they are incorporated with other machines of the organism appropriated to certain movements, or they are distributed over the skin or other parts of the body, as the eyes, ears, etc., without exciting such machines to motion, if they be appropriated to certain movements, or at least without co-operating therein. The first are termed, in relation to their function, *motor nerves*; the other are *sensitive nerves*. They are, however, identical in structure and only differ in their local relation. Each nerve may be either the one or the other, according to its distribution, and each motor nerve is at the same time endowed with the properties of the sensitive. The motor nerves have ganglia, composed partly of their own fibrils, and partly of other nervous twigs and nerves which accompany them, whereby the direct course of the fibrils and nerves is interrupted. The nerves of the senses, which have no motive influence on the mechanical machines of the organs, have no ganglia.

"All the phenomena of motion and sensation manifested through the nerves, render probable the existence of a remarkably subtle fluid essence, which is present invisibly in the medulla of the brain and nerves, and is the means whereby all the functions of both are performed. It is termed the *vital spirits* or *nervous fluid*, but it is not known how and when it contributes to the animal actions. It is not that fluid matter which is seen in the medulla of the brain and nerves, but a much more subtle spirit, imperceptible to the senses. It is inferred from the phenomena which betray its existence, that this nervous fluid is a remarkably mobile fluid, a spirituous vapour, which can be neither aqueous, not glutinous, nor elastic, nor ethereal, nor electrical, pp. 17–18. * * *

"The seat of the soul is in the brain. Whenever the brain is destroyed, or its natural functions interrupted, the sentient force ceases to act. So soon as it is restored to its natural functions, conceptions return. The whole brain is not immediately necessary to thought, since large portions of it may be lost or be defective, or be compressed, or ossified, or its functions otherwise interrupted, without any perceptible influence on the mental powers, which, as to the cortical substance at least, is not remarkable, because it is not the seat of mind; but it cannot be deduced from any observation whatever, that the whole brain may be wanting, (as, for example, when the head is removed, or the brain entirely destroyed, or the functions of all its parts generally interrupted), and the slightest trace of mental operations ever be perceived. Further, when a thought arises in the mind, a change must necessarily occur concurrently therewith in the brain, and particularly in the medullary substance, without which the sentient force cannot act; and when this change occurs in the brain, the sentient force is necessarily excited into action.

Whatever may be reasoned on the matter, a change in the brain must consist in a movement, and the medullary matter must also be endowed with a motive force, which acts in harmony with the sentient force. So that each distinct class of perceptions is always connected with certain animal movements, and with the movements of a certain class of perceptions; for it is ascertained from numerous observations, that after certain injuries of the medullary portion of the brain, especially of that part from which the nerves of sensation arise, certain kinds of perceptions, as for example, certain sensations, are prevented or disappear, and together with them all the ideas, desires and instincts dependent thereon, as well as other faculties of the mind. (Haller.) This motive power of the brain, which is connected with the sentient force (mind), is an animal-sentient force, and hence arises *the fundamental general principle in the doctrine of the connection between body and mind, that the medullary matter of the brain possesses an animal-sentient force, by means of which, at every act of mind, whether it be a sensation, imagination, desire, reflection or conclusion, there is produced in it a certain animal movement, necessary thereto, without which the act of thought can neither arise nor continue, and with which it infallibly arises and continues*, p. 24. * *

"External impressions may be made on many nerves at the same time, and the mind can distinguish all and each of the external sensations thence arising, although the impressions come from the most distinct nerves into a common trunk (as, for example, the spinal cord), before they reach the brain, and there form the material ideas of an external sensation. In the same nerve, and at the same time, different impressions may be made, yet the mind accurately distinguishes them; so that every external impression on each part of a nerve takes also an uninterrupted course to the brain, and can there form the material sensation peculiar to itself, and distinct from all others, without being confounded or mingled, either on its way with other impressions ascending at the same time, along the nerve, or with the material sensations which arise at the same time in the brain. The reason of this is, that the terminating fibrils which receive the impressions, run a distinct course to their origin, and remain quite separate, however they may be united with other fibrils to form an entire nerve, or however the latter may be united to form larger trunks, as the spinal cord. Further, at the place of origin of the nerve in the brain, there is a distinct point where the material ideas must be developed from the external impressions which it brings to the brain." Chap. 11, pp. 36–37.

"It is incontrovertible that many nerves, although sensitive, are mainly appropriated to certain special movements; and that the external impressions necessary thereto, are seldom or never transmitted to the brain, or only those of a certain kind; but that, for the most part, it is their normal condition to remain in the nerve. The nerves of the stomach, intestines, and heart illustrate this point.

"What prevents the propagation of all these impressions to the brain? There is nothing to be found in the nerves adapted to this end, except certain formations found scattered on the motor nerves, termed ganglia, and the point of insertion of the smaller fibrils in the larger trunks, where also a sort of ganglion is formed. At those points the direct course of the fibrils is interrupted, and here the external impression traversing them can be deflected, and its transmission to the brain prevented; the more especially, as the outer thick coat of the ganglion acts in some degree as a muscle, and by a slight compression, can hinder the transmission (Monro). But is it not probable that an external impression on motor nerves of this kind, is expressly intended, when it reaches the ganglion, to be deflected to the trunk or branch of another nerve, or to another fibril of the same nerve interwoven in the ganglion? For thereby it would cause a reflected or retrogressive action in the fibril, as if an impression were excited in it, and sent from above downwards, or as if sent from the brain; when thus deflected, it puts certain parts into movement, just as an impression really transmitted along the nerves from above downwards, and so imitates the latter by this reflected course. If, however, this conjecture be groundless, still the fact remains, that external impressions on certain nerves, not received directly, excite movements without reaching the brain, and without being felt." Chapter 11, pp. 41 and 42. * *

Thus, it is intelligible, how a nerve may retain its sensibility and yet have lost motor power; being sensitive and yet paralysed, as it is often observed. If on the other hand, the obstruction involves those fibres only at the cerebral origin of the nerve which transmit the external impression to the brain, the latter will develop no material idea in the brain and no sensation in the mind; but a spontaneous conception can excite a material idea (an internal impression) at the origin of the nerve, and this may be transmitted along the fibres, and produce actions in the body, such as a voluntary movement for example. In other words, the same nerve may be insensible, and still the channel of the will. How could it be possible to explain these two classes of phenomena, if the existence of this difference in the fibrils of the same nerve be not admitted? It is manifest to every one, that the nervous fibrils are distinct, and separated from each other at their origin. From these and other considerations, which will be stated subsequently, this doctrine of two distinct classes of nerve-fibrils existing in the same nerve, and which are appropriated to the two kinds of the internal and external impressions respectively, acquires an air of truthfulness which renders it worthy of acceptance, p. 68. * *

"The nerves may have an influence over the blood vessel, on the secretions, and on the whole circulation, in various ways. In the first place, through the *heart*, a compound hollow muscle, throughout which nerves from various sources are distributed as in other muscles. These nerves, like all others, can receive external impressions, since an animal feels when the heart is pricked or irritated. They consequently transmit external impressions in such cases to the brain, and produce therein at their origin external sensations, or cerebral impressions. When there is no impediment, these are propagated downwards along the same nerve, and, consequenly, may not only have an influence on the movement of the heart, but may excite sentient actions. In the same way, the sensational conceptions, desires, and aversions, sometimes excite cardiac movements, which are sentient actions produced through the nerves by various material external sensations; examples of this kind are numerous, as when ideas, foreseeings, and emotion-change the movements, p. 90. * *

"The nerves have another influence; namely, on the vascular system generally, since they are incorporated with the coats of the arteries, and thereby probably supply animal force to the muscular fibres which they surround. * *

"A third kind of influence possessed by the nerves, is on the vessels distributed to the muscles. It almost necessarily follows, that the numerous blood vessels distributed in them are affected by the contractions excited by the nerves, consequently the latter indirectly favor the circulation of the blood in the veins, and agitate and mix that in the arteries, thereby favoring its course towards the lungs. They regulate the secretions of the liver mesentery, etc., and diminish or retard them, they urge on the blood, and the large muscles of the abdomen impel the blood contained in that cavity towards the heart. (Haller's Physiology, § 416). Many of these acts are sentient, nay, are even volitional; and if to all these actions of the nerves on the blood vessels and the circulation, the direct action of the brain on its multitudinous capillaries be added, it is clear that this apparently simple mechanical motion of the heart is much under the important influence of the mind, and the still more important influence of the nerves, p. 92. * *

"The glands are a tissue of vessels and nerves, and their function is to separate the secretions from the blood. The nerves exercise the same influence on these as on other vessels, and, consequently, secretion, which ordinarily appears to be simply physical, is not only animal, but is also sometimes a sentient action. The nerves have the most manifest influence on those glands which are surrounded by muscular tissue, or so placed between muscles that the latter by their action, express the fluid from the glands when secreted; so that it is poured out. Examples of this kind are the penis (Geilen), the urinary bladder, the bowels, the stomach; also the parotid glands which are emptied by the action of the muscles of mastication. (Haller's Physiology, § 233). Many glands pour out their secretions from external sensation, (titillation—pain); many from imaginations, sensational anticipations, desires, etc., as, for example, the salivary glands from the recollection or anticipation of an agreeable taste, or in hunger; many from passions, as the lachrymal and sexual glands; many even from acts of will, as when the saliva is stimulated to flow by voluntary mastication, or weeping is feigned.

"The action of the nerves in the viscera is very complex, varying with the number of nerves distributed, or with the various impressions of which the latter are susceptible; or they are influenced by the muscles, muscular tissues, glands, etc., which surround, or are in relation to them; or as the nerves act directly or by sympathy, p. 94. * *

"Nevertheless external impressions on nerves can proceed to the brain without exciting a visible movement in the point touched,—can be felt,—and can be reflected by means of the internal impressions of the sensation along the principal nerve and its branches, and if there be no hindrances, can excite movements in the mechanical machines to which the nerves are distributed, and, consequently, develop sentient actions in other parts by means of the external sensation thus excited on such surface. Thus titillation of the mucous membrane of the nostrils excites sneezing, and a convulsive movement of the diaphragm and respiratory muscles, the nerves of which are in natural connection with those of the nasal mucous membrane; thus, also, many an external sensation of the cutaneous surface excites by means of the nerves, a tremor of the muscles in relation to it, which is termed a *shudder*. Thus, also, a titillation of the nasal mucous membrane excites effusion of mucous, which is a sentient action of titillation in the capillaries or terminating tubuli of the minute glands. Thus, also, the cutaneous surface becomes inflamed, and swells from the stimulus of an acrid irritant. Thus, also, cold contracts the respiratory pores by a sentient action on the minute terminations of the arteries, and interrupts perspiration." Chapter III, pp. 108–109.

"External sensations excite the functions of the *glands*, namely the *excretion of fluids*; and when they are enclosed in muscular tissues, the evacuation takes place according to their mode of action on muscular tissues; but when there is no muscular tissue, they excite an afflux of fluid, in virtue of their action on the terminating mouths of the tubuli. Thus a strong flavour excites the secretion and discharge of the saliva; irritation or pain in the eye, excites the flow of tears; thus, also, titillation causes parts to be lubricated, by irritating the nerves of the glands, and favoring a secretion and discharge of their fluids; and, also, irritation and pain of the bronchi cause a mucous discharge from the irritated glands—all being manifestly sentient actions in the glands, from external sensations." Chapter III, p. 110.

"*The external impression on the nerves can produce the same movements in the body as if it were felt, although it is not felt, nor transmitted to the brain.*

"If the nerve of a limb be irratated with a needle, movements take place exactly similar to those produced in the natural condition by the volitional conceptions; thus, the diaphragm renews its motions, as in respiration, if the trunk of its nerve be irritated; the body of a dog, or of an ox, (nay, even of a man, as is seen in executions by decapitation), will be thrown into the most violent volitional movements when the spinal cord is cut through; if in such an one the cord be irritated inferiorly, the movements involve the feet only; if superiorly, panting, respiration, palpitation, deglutition and vomiting result. When an irritation of the spinal cord produces spasmodic convulsion of the whole body, but a particular nerve has been previously divided, the limb to which that nerve is distributed is unaffected by spasmodic action, because the irritation cannot be transmitted to it; thus, also, a decapitated frog rises up and springs forward, and if thrown into water, begins to swim so soon as its spinal cord is irritated with a needle in the cervical region, just as if it knew what it had to do. Bilguer relates a somewhat similar case, in which, if a certain part of the neck, where suppuration had taken place, was irritated, the patient was obliged to stand upright in spite of himself, etc. A great variety of well authenticated facts of this kind may be found in Haller's Physiology.

"The *movements* of the *limbs* display the influence of the *vis nervosa* strikingly, because its action is greatest on the muscular portion of the organism. These, as a thousand experiments prove, may arise, as nerve actions, although they usually occur as sentient actions from external sensations and sensational conceptions, instincts and passions, as well as volitionally. Thus a decapitated animal will stand, move forward, raise itself up, leap, fly, or flutter its wings, seek food, clean, defend or conceal itself, copulate, etc. A decapitated man, immediately after decapitation, struggles to free his hands, attempts to stand upright and to stamp with his feet; if the head of a pigeon be cut off whilst it is running, it continues to run on for some distance, until it knocks against something; a frog leaps forward without its head, so, also, a headless fly flies, a snake, a fish, a worm, writhes and twists about if touched, although wholly deprived of sensation; a fly makes the movement of brushing its eyes, by a natural instinct, although its head be cut off; a headless snail seeks its food by its usual plan of feeling about; a decapitated tortoise does the same thing, and will live for half a year after decapitation, and raise itself up, or endeavor to do so, if placed on its back; an ear-wig nips with the nippers of its abdomen at its own separated head, when the head bites the abdomen; the abdomen of a wasp will sting; animals that fight with their hind feet, use them vigorously when decapitated at every irritation applied to the nerves; butterflies, catterpillars and silk worms copulate after decapitation, and they and flies deposit their ova; in short, all the instinctive actions of animals are sometimes seen to occur as nerve actions; and it naturally follows that they occur at first in newly born animals as such, and that it is only after the perception of external sensations, that they become sentient actions." p. 213.

"The following irrefragable truth follows from these two leading principles: *While the animal machines are endowed by nature with the property of conducting external impressions to the brain, so that they may there excite material ideas, giving rise to sensations, and of receiving internal impressions caused by conceptions, they also possess another and entirely different property, and are intended by nature to effect, by means of the external impressions they receive, whether the latter reach the brain and are felt or not, the same movements which are effected when they do reach the brain, and are felt: and to effect, by means of an internal impression, which they receive from a touch or irritant caused by no conception whatever, the same movements as are effected by means of the cerebral forces, when the same internal impression is produced by a conception.* p. 192.

"In animals with a sentient brain, every external impression which is felt passes directly to it, and excites therein a material idea, and in the mind a conception. Having reached the brain, it is turned back or reflected, as it were, and goes back as an internal impression of a conception, into those nerve fibrils that move the limb, which the external impression is enabled to control by means of a sentient action of its sensation. * * When a polype receives external impressions, they pass onwards to the nearest ganglion whence they are reflected as if from a brain, either entirely, or in such a way, that they only partly reach other ganglia, and thus they can be reflected many times. It is sufficient that at these points the external impressions are transferred into internal, and pass again from the ganglia along the nerves to the mechanical machines, which they put in motion, no act of thought taking place during the transformation, because there is no brain, (for in that only is the seat of the conceptive force), nor are the internal impressions adopted to excite a sentient action." pp. 197–198.

"An external impression is changed into or develops an internal impression, whenever its course, which is naturally towards the brain from the terminating fibrils, is so reflected or turned back, that it returns in the direction from the brain downwards to the branches and terminations of the nerves. * * In the nerves there is no place in which it can occur, except the ganglia of the motor nerves, and at their separation into branches and fibrils. According to all probability, these ganglia and points of division of the nerves, perform in the motor nerves the office of the brain, in relation to the external impressions, since they deflect these from their course upwards, and communicate an internal impression, either to other nerves and their branches, or to different fibrils in the same nerve, conducting in the direction of the brain downwards, whereby these twigs and fibrils are suitably stimulated, and such muscular movements excited, as would have been caused if the external impression had reached the brain and been turned back or reflected from thence by the intervention of an external sensation. p. 215. * *

"This explains what takes place in similar circumstances, when an impression is made on the spinal cord, and spasms and convulsive movements are excited in all parts below the point of irritation, except those, the nerves of which are cut through. The reflected external impression passes as an internal impression to, and only excites movements in those muscles to which it can be transmitted from the point of reflection. p. 224.

"Examples of this class of nerve-actions are to be met with daily, which sometimes are mistaken for sentient actions (which they often accompany), sometimes for special operations of unfelt external impressions acting through the brain, sometimes for inexplicable sympathies." p. 224.

(The Principles of Physiology, by John Augustus Unzer; Translated and Edited by Thomas Laycock, M. D., Sydenham Society, July, 1851).

George Prochaska, born at Lospitz, in Moravia, April 10th, 1749 (Professor of Anatomy and Diseases of the Eye, at Prague, 1778, Professor of Anatomy, Physiology and Diseases of the Eye, at Vienna 1791), published his work, "De Functionibus Systematis Nervosi," in 1784.

Prochaska adopted the principle of a general sensorium commune, but subdivided it in accordance with the views of Willis, into a rational and corporeal soul in man; thus, the sensorium commune of the soul is seated in the brain only, and reflects the impressions of which we are conscious; and the sensorium commune of the body, which is seated in the brain, spinal cord, and ganglia and plexuses of the sympathetic system.

Thus Prochaska held that the brain only is the seat of the *soul sensorium*: the seat of the body *sensorium* is the brain and spinal cord, and, as all observation shows, the ganglia and plexuses of the nerves. That external impressions can also be reflected in the brain without consciousness, is shown by the involuntary convulsions of voluntary muscles. Monsters born without brain and spinal cord, and which live up to the moment of birth, show that the consensus of the nerves, necessary to this form of life, imperfect though it be, may take place, and that there may be a corporeal sensorium independently of the brain and spinal cord, and which consequently must be constituted by the plexus and ganglia of the nerves. The movements observed to take place on irritating the nerves of a headless frog, and seen also in decapitated men, prove the same thing. The sympathetic nerve appears likewise to reflect its impressions in its ganglia and plexuses, without the consciousness of the soul.

In accordance with this consensus of the nerves, as well in the brain as in the spinal cord, ganglia and plexuses, the operation of a stimulus is not limited to the nerves immediately irritated, but is extended to distant nerves, in known or unknown connexion with the irritated nerves; and this is demonstrated by innumerable examples of consensus of nerves, as, for instance the irritation in the pregnant uterus, often causes nausea, vomiting, headache, toothache, etc.

Prochaska used the term, "*vis nervosa*," to designate that agent, by which the nervous system is rendered fit for the performance of its functions. Prochaska illustrated the mutual connection or law of "self-conservation," between the "soul sensorium and body sensorium," by various facts:

"For instance, the irritation or impression of too strong a light, goes to the optic nerve, from whence it can only get at the ciliary nerves through the brain, and induce contraction of the pupil, so as to exclude the too vivid light from the eye, and obviate its unpleasant impression."

He gives the following examples of reflex actions.

> * * "Very many instances which might be adduced, undoubtedly prove this general law of the reflections of the sensorium commune, of which it may be sufficient to mention a few. Irritation being made on the internal membrane of the nostrils excites sneezing, because the impression made on the olfactory nerves by the irritation is conducted along them to the sensorium commune, there by a definite law is reflected upon motor nerves going to muscles employed in respiration, and through these produces a strong expiration through the nostrils, whereby the air passing with force, the cause of the irritation is removed and ejected. In like manner it happens that when irritation is caused in the trachea by the descent of a particle of food, or a drop of fluid, the irritation excited is conducted to the sensorium commune, and there reflected on the nerves devoted to the movement of respiration, so that a violent cough is excited, a most suitable means for expelling the cause of irritation, which does not cease until the irritant be ejected. If a friend brings his finger near our eye, although we may be persuaded that no injury is about to be done us, nevertheless, the impression carried along the optic nerve to the sensorium commune, is there so reflected upon the nerves devoted to the motion of the eyelids, that the eyelids are involuntarily closed, and prevent the offensive contact of the finger with the eye. These, and innumerable other examples which might be brought forward, manifestly show how much the reflection of sensorial impressions into motorial, effected through the sensorium commune, has reference to maintaining the conservation of the body.
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> "Since the principal function of the sensorium commune thus consists in the reflection of sensorial impressions into motor, it is to be noted that this reflection may take place, either with consciousness, or without consciousness. The movements of the heart, stomach and intestines, are certainly in nowise dependent on the consciousness of the soul, for whilst no muscular movement can be excited, unless a stimulus applied to the sensorial nerves passes, by a peculiar reflection, to the motor nerves, and excites contractions of the muscle, it is at the same time certain that the reflection of the impressions suitable for exciting those movements, if it take place in the sensorium commune, is effected without consciousness. But it is a question whether these impressions, in order that they may be reflected, do really travel so far as the sensorium commune, or, without taking this long circuit, are reflected nearer in the ganglia, from whence these parts derive many nerves? But that reflection of sensational impressions into motor are effected in the sensorium commune itself, while the mind is altogether unconscious, is shown in certain acts remaining in apoplectics deprived entirely of consciousness; for they have a strong pulse, breathe strongly, and also raise the hand, and very often unconsciously apply it to the affected part. The sensorium commune also acts independently of consciousness in producing the convulsive movements of epileptics, and also those which are sometimes observed in persons buried in profound sleep, namely, the retractions of pinched or irritated limbs, to say nothing of the motion of the heart, and of the respiratory acts. To this category also belong all those motions which remain for some time in the body of a decapitated man, or other animal, and are excited when the trunk, and particularly the medulla spinalis, are irritated, which motions certainly take place without consciousness, and are regulated by the remaining portion of the sensorium commune existing in the medulla spinalis. All these actions flow from the organism, and by physical laws peculiar to the sensorium commune; and are therefore spontaneous and automatic. The actions taking place in the animal body, with accompanying consciousness, are either such as are independent of volition, or such as the mind can restrain and prohibit at pleasure; the former being governed by the sensorium commune alone independently of the mind, are as much automatic as those of which the soul is unconscious. Of this character are sneezing, from an irritant applied to the nostrils, cough, from an irritant fallen into the trachea, vomiting, from a titillation of the fauces, or after taking an emetic, the tremors and convulsions in St. Vitus' dance, and in a paroxysm of intermittent fever.
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> "Further, it may be asked, whether the external impressions made on the terminations of the nerves and passed onwards to the ganglia are extinguished in the ganglia themselves, or whether, being reflected by a fixed law, they return again along the nerves to the parts to be moved? The celebrated Unzer, and the eminent Winterl taught, that external impressions are reflected in the ganglia, as they are reflected in the *sensorium commune*, and that the ganglia are special sensoria,—a doctrine which does not appear altogether destitute of probability. For if we consider that the minute and invisible nerves disseminated over the internal membrane of the heart and auricles, perceive the stimulus of the inflowing venous blood, and although they cannot transmit the impression of that stimulus to the *sensorium commune* through the ganglia of the intercostal (great sympathetic) nerve, yet communicate it to the motor nerves distributed through the substance of the heart (ventricles) and auricles, it follows that there is necessarily a consensus between the sensory nerves distributed on the inner membrane of the heart and the motor nerves disseminated through the substance of the heart (ventricles) and auricles, which must take place either in ganglia of the intercostal nerve, or below them, in the communicating branches or plexuses of nerves. It seems probable, therefore, that besides the *sensorium commune*, which we conjecture to be in the *medulla oblongata*, *medulla spinalis*, *pons varolii* and *crura* of the *cerebrum and cerebellum*, there are special *sensoria* in the ganglia and plexuses of the nerves in which external impressions ascending along the nerves are reflected, that need not ascend all the way to the *sensorium commune*, to be reflected thence."

Prochaska also thus notices the important distinction between the two great classes of involuntary and voluntary acts:

> "Nevertheless, this need for rest seems only to be a characteristic of the nerves which are subordinate to the will and not to the involuntary, which have to provide for the motion of the heart, respiration and digestion; and whose vis-nervosa is active, without intermission, during the whole of life, although it may be weaker or stronger; though it cannot be doubted, that both kinds of vis have a similar origin, and are of the same nature, still observation shows that the one belongs to the will, the other is involuntary; that the former is exhausted by sensation and motion, and requires rest and repose; with the latter the contrary takes place; and finally, that the two kinds of vis are independent of each other. This distinctness and independence of the voluntary and involuntary vis-nervosa is shown, not only in sleep, but also in apoplexy, when the voluntary vis-nervosa is quite arrested, but the involuntary performs its duty. So, also, in cases of fever, the voluntary vis-nervosa is quite weakened, but the involuntary is so much the more active."

Prochaska records, in his careful and comprehensive description of the different parts of the nervous system, the fact that the fifth pair of nerves, and all the spinal nerves, are enlarged near their origin by ganglions. In like manner, with Unzer, he dwells upon the fact, that nature proceeds gradually from the most perfect and highly complex brain, to the simpler and simplest; and that, at last, animals exist altogether devoid of brain.

Prochaska also noticed the influence of the nervous system over the blood vessels, and especially the capillaries; and refers the congestion and increased secretion induced by local irritants and certain medicines, as purgatives, not merely to the irritation of the extremities of the nerves, but also to a reflex action. Thus, he says:

> "These phenomena take place if the nerves be stimulated locally; but the same thing happens when the nerves are excited, not directly, but indirectly through the brain. We know that thus the face is suffused with the

> blush of modesty; grief causes a copious flow of tears, congestion of the vessels of the conjunctiva and swelling of the whole face. The sight of agreeable food provokes the saliva; it is not unusual for some persons to vomit or be purged by only seeing a medicine; a lascivious idea erects the penis, etc.
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> "The face of a man struck with sudden terror is pale, and some men become pale when in a paroxysm of rage, which paleness is without doubt owing to a repulsion of the blood from the cutaneous blood vessels, to those in the interior of the body. Inasmuch as the nervous system is affected in terror or rage, the question arises, whether the cutaneous nerves then affected completely repel the blood from the cutaneous vessels, by contracting them to the inner vessels of the body?
>
> "Other phenomena occurring in the natural state, besides those mentioned in the preceding paragraphs, are intelligible by this congestion arising in the irritated part. And in diseases there are frequently opportunities for observing the operation of that nervous influence on the vessels, in virtue of which fluids flow more copiously and immediately to the irritated parts. Inflammation itself is nothing else than a powerful attraction and deviation of blood from a stimulus, by which the vessels become filled, swell, are rendered tense, red, painful, etc. If this stimulus be sufficiently powerful, it draws the nerves of the heart into sympathetic action, and by increasing the movements of the latter, produces fever, the concommitant of inflammation."

Prochaska also discussed the question. "*Have the nerves any influence on secretion?*"

Boerhaave, in considering the causes which operate in producing such varied secretions from the blood, did not attribute any definite share to the nerves; Haller conjectured that the nerves operate in the secretion of the fluids, since they surround the vessels of the viscera like sphincters, and thus either delay or promote secretion; Tissot also devoted an entire section of his work on the functions and diseases of the nerves, to the secretions, for the purpose of demonstrating how much the latter are dependent on nervous influence.

The observations of Prochaska on this subject, are of special interest when viewed in the light of recent experiments upon section of the sympathetic, and injuries of certain parts of the spinal chord. Thus he remarks:

> "In truth, since it has been shown how great is the influence of the nerves on the vessels, in virtue of which stimuli can excite a more copious flow of fluids to a part, we infer that the same thing occurs in the secreting viscera, which consist almost entirely of vessels. So soon, therefore, as, by nervous action, the fluids are more copiously attracted to secreting viscera, the secretions are necessarily increased. Moreover, since the nerves have the property of causing spasms, or contraction of the capillaries, it is manifest that the secretions may be diminished, or entirely interrupted by the influence of the nerves, the secreting vessels being entirely closed by constriction."

Prochaska adduces various examples, as the putrid and dissolved state of the blood in fevers, the effects of section of the eighth pair of nerves in altering the character of the secretions of the stomach; the vomiting of fœtid, bilious matter, excited by disease of the brain and by irritation of calculi passing along the ureters, diarrhœa, excited by mental emotion, the effects of anger in producing jaundice, and in rendering the milk of the nurse unpleasant in taste and injurious to the child, the effects of the bites of enraged animals, to prove that the influence of the nerves on the fluids is so great, either at the time of secretion, or when secreted, that it can modify or alter them, or entirely change their nature.*

Marie Francois Xavier Bichat, born November 11th, at Thoirette, in the present department of the Ain, undertook his first course of Anatomy in 1797, and published his remarkable work "On Life and Death,"† in 1799.

Bichat proposed to divide the nervous system into two distinct departments: one, composed of the encephalon and spinal marrow and their annexes, subserving the operations of the understanding and the will, and constituting the principal organ of the life of relation, or animal life; the other included the great sympathetic, with its ganglions and plexuses, giving impulse to the acts of organic or individual life, or those functions, in virtue of which an individual transforms into his own structure nutritive molecules, and casts off those which are effete, or worn out, and injurious to the system.

Whilst Bichat formed distinct conceptions with reference to the influence of these grand divisions of the nervous system, and urged with force and eloquence his views as to the differences between the animal and organic life, he failed to recognize fully the mutual connections and relations of the cerebro spinal system of animal life, with the sympathetic system of organic life), and his physiology of the nervous system, as a whole, was inferior in accuracy and completeness to the systems of Unzer and Prochaska.

According to Bichat, the functions of the animal are of two very different classes. By the one, (which is characterised by an habitual succession of assimilation and excretion, it lives within itself, transforms into its proper substance the particles of other bodies, and afterwards rejects them when they have become heterogeneous to its nature. By the other, it lives externally, is the inhabitant of the world, and not, as a vegetable, of a spot only. It feels and perceives, it reflects on its sensations, it moves according to their influence, and frequently is enabled to communicate by its voice its desires and its fears, its pleasures and its pains.

The aggregate of the functions of the first order, Bichat named the *organic life*, because all organized beings, whether animal or vegetable, enjoy it more or less, and organic texture is the sole condition necessary to its existence. The sum of the functions of the second class because it is exclusively the property of the animal, he denominated the animal life. He regarded the sanguiferous system as a middle system, the centre of the organic life, as the brain is the centre of the animal life. In this system, the particles, which are about to be assimilated, are circulated and are intermixed with those, which, having been already assimilated, are destined to be rejected; so that the blood itself is a fluid composed of two parts; the one the pabulum of all parts of the body, and derived from the aliment, the other excrementitious, composed of the wrecks and residue of the organs, and constituting the source of the exterior secretions and exhalations.

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* "Dissertation on the Functions of the Nervous System, by George Prochaska, M. D." Translated and Edited by Thomas Laycock, M. D., etc., Sydenham Society, 1851, pp. [illegible].

† "Physiological Researches on Life and Death, by Xavier Bichat." Translated from the French by R. T. Gold.

As defined by Bichat, the animal and organic life, are each of them composed of two orders of functions, which succeed each other, and are related and manifested in an inverse direction. Thus, in the animal life the first order is established from the exterior of the body towards the brain; the second from the brain towards the organs of locomotion and the voice. The impression of objects successively affect the senses, the nerves and the brain; the first receive, the second transmit, the third perceives; the impression, in such way received, transmitted and perceived, constitutes sensation. The animal, in the first order of their functions, is almost passive; in the second, he becomes active. This second order is the result of the successive actions of the brain (where volition has been produced in consequence of the previous sensation), and of the nerves which transmit such volition, and of the locomotive organs and voice, which are the agents of volition. External bodies act on the animal by means of the first order of functions, the animal re-acts upon them by means of the second. In general there exists between the two orders a rigorous proportion; when the one is very marked, the other is put forth with energy; in the series of living beings, the animal which feels the most, also moves the most.

A double movement is also exercised in the organic life; the one composes, the other decomposes the animal. Such is the mode of existence in the living body, that what it was at one time, it ceases to be at another. Its organization remains unaltered, but its elements vary every moment. The molecules of its nutrition, by turns absorbed and rejected from the animal, pass to the plant, from the plant to inorganic matter, return to the animal and so proceed in an endless revolution.

Bichat endeavored to establish the following general differences between the two lives: The organs of the animal life are symmetrical, those of the organic life are irregular in their conformation and position; the animal life is, as it were, double, its phenomena performed, as they are, at the same time on the two sides of the body, compose a system in each of them independent of the opposite system; on the contrary, the organic life is a single system in which everything is concatenated and concentrated where the functions on one side cannot be interrupted, and those on the other side subsist. Harmony is the character of the animal, discord that of the organic functions; the functions of the animal life intermit, the functions of the organic life are performed with an uninterrupted continuity; in the animal life everything is modified by habit; the organic life is, on the other hand uninfluenced by habit; whatever relates to the understanding belongs to the animal life, whatever relates to the passions belongs to the organic life; the organic life is the term in which the passions end, and the centre from whence they originate; the vital properties are only those of perception and motion, but in the two lives they possess a very different character; in the organic life, sensibility is the faculty of receiving an impression; in the animal life it is the faculty of receiving an impression, plus that of referring such impression to a common centre; there is an animal contractility which has its principle in the brain, and is essentially subject to the influence of the will, and receives from the brain the irradiations which put in motion, and ceases to exist when the organs, in which it is observed communicate no longer with the brain; and there is an organic contractility, which is not dependent upon a common centre, has its principle in the moving organ itself, is a stranger to the influence of volition, and gives rise to the phenomena of digestion, circulation, secretion, absorption and nutrition.

Nothwithstanding the strong lines in which Bichat drew the apparent distinctions between the animal and organic lives, he admitted that though at the first glance, the two sensibilities present a remarkable difference, their nature nevertheless was essentially the same—the one being only the maximum of the other. Thus he says:

> "It is evident that the distinction above established, with respect to sensibility consists in the different modifications of which this power is susceptible, and not in its nature, which is everywhere the same. This faculty is common to all the organs and forms their true and vital character; but as it is more or less abundantly distributed to each, it gives to each a different mode of existence. No two parts enjoy it in the same proportion. In these varieties there is a degree above which the brain is the term of it, beneath which the organ alone is sensible of the impression. If to render my ideas on this head, intelligible, I am to use a vulgar expression, I should say that distributed in such a dose to an organ, sensibility is animal; in such another dose organic. Now that which varies the dose of sensibility, is sometimes the order of nature (in which way the skin and the nerves are more sensible than the tendons and cartilages); at other times disease; thus in doubling the dose of sensibility to the cartilages, inflammation renders them equal in this respect, and even superior to the former, and as a thousand causes, may at every moment exalt or diminish this power in any part of the body, it may be changing from the animal to the organic type."

Bichat labored strenuously to establish the entire independence of the cerebro-spinal and sympathetic systems: and the fundamental proposition of his book, upon which the whole chain of reasoning rests, as to the difference between the animal and organic life, rests on the idea, that the ganglions cannot transmit the action of the brain to the different organs, because the nervous system formed by the ganglions, is entirely independent of the nervous system of the brain. He affirmed in the most decided manner, that the great sympathetic did not derive its origin from the brain, nor from the spinal marrow, nor from the nerves of animal life: in fine, according to Bichat, this nerve does not exist, and the so-called sympathetic, is only the aggregate of as many small nervous systems, as they are ganglions, which are the particular centres of the organic life, just as in the same way, the brain is the great and only centre of the animal life.

Notwithstanding this distinct and articulate enunciation of the absolute independence of the animal and organic systems, Bichat was compelled by numerous facts, to admit that the two systems were closely related, and could mutually act and re-act upon each other; such action and re-action being referred to the vague action of the sympathies. Thus he held, that:

> "The most numerous sympathies exist between the internal viscera and the brain, or its different parts. Every step which we make in practice, presents us with affections of the brain originating sympathetically, from those of the liver, stomach and intestines. Now, as the effect of every kind of passion is to produce a change of power in the one or the other of these viscera, such change will sympathetically excite either the whole of the brain or some of its parts whose re-action upon the muscles, which receive from thence their nerves, will produce the motions which are then observed. In the production of these motions the cerebral organ accordingly must be passive, it is active only when the will presides over its effects. The effects indeed of the passions, are similar to those diseases of the internal organs which by sympathy are the causes of atony, palsy and spasm. * *
>
> "A man is informed by letter and in presence of company, of a bad piece of news, which it is his interest to conceal: suddenly his brows contract, he grows pale, and his features are moulded according to the nature of the passion which has been excited. These are sympathetic phenomena produced by the abdominal viscera, which have been affected by the passions, and which, in consequence, belong to the organic life. But in a short time, the man is capable of putting a restraint upon himself, his countenance clears up, his color returns. Meanwhile the interior sentiment continues to subsist however, but the voluntary have overpowered the sympathetic motions, the action of the brain has surmounted that of the stomach or liver; the animal life of the man has resumed the empire."

Cuvier in his Lectures on Comparative Anatomy, delivered in 1800, and translated and published in English in 1802, presented an elaborate description of the cerebro-spinal and sympathetic nervous systems, in man and in vertebrate and invertebrate animals.

Cuvier regarded the *ganglia*, when considerable, as each a kind of secondary brain, and observes that they are larger and more numerous in proportion as the principal brain is less.

Cuvier gives the following observations upon reflex actions:

> "The general organ by which we exercise the faculty of sensation, is the medullary substance. In all the animals in which we can distinguish it, that substance is divided into filaments, which, arising from certain centres, distribute themselves over most parts of the body, where they appear to serve other properties besides that of procuring sensations. The centres from which those nervous cords proceed, communicate with each other in a manner more or less intimate, and several of the filaments seem of no other use then to establish those communications. * *
>
> "The soft white substance which forms the essence of this system, is divided into filaments that approach each other, and unite in bundles, which contain more filaments in proportion as they are traced nearer to the common fasciculus of all the nerves, called the spinal marrow, the anterior extremity of which is joined to the brain, that is to say, to a medullary mass of more or less magnitude, and differently formed according to the various kinds of animals. From the action of external bodies on our own, we perceive that the nerves affected by that action communicate with the common fasciculus, and that it communicates with the brain. Lecture I, Animal Economy, Art. ii.
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> "There appears besides, in the nervous system, certain phenomena which depend on the union of different nerves, whether that communication be produced by cords passing from one to the other, or through the medium of the brain. These phenomena are called *sympathies*; they consist of involuntary motions, or rather of sensations, experienced in places different from those that are affected. These sensations do not seem to depend upon the influence of the will, or the imagination, and frequently exist while we are ignorant of the place really affected, or the motion that has occurred.
>
> "The sneezing which succeeds to irritations of the nostril, affords an example of the sympathy produced by the union of nerves; the nerves of the nostrils, which come from the opthalmic branch of the fifth pair, are connected by the sympatheticus major, with the nerves of the diaphragm, and by this means the excitement is communicated. The sneezing which takes place upon looking at a bright light, is to be ascribed to the union of the ciliary nerve with the fifth pair; the irritation is communicated to the nose, and thence to the diaphragm.
>
> "Another example of the same kind consists in the great changes which the eyes present in different internal diseases of the body. These changes so important to the physician, are almost all produced by the union of the sympatheticus major with the fifth pair, and by that pair with the ciliary nerves.
>
> "Sympathetic affections occur still more frequently, where different parts of the body receive branches of the same nerve which may communicate irritation.
>
> "Thus tears are excited by a strong smell. This is occasioned by the opthalmic nerve sending at the same time branches to the nostrils and the lachrymal gland.
>
> "The vomiting produced by pushing a finger into the throat, is owing to the distribution of the eighth pair of nerves, which go both to the pharynx and to the stomach.
>
> "The eighth pair, or nervus vagus, and the great intercostal or trisplanchnius, are the nerves which produce the greatest number of this kind of phenomena, because they are distributed to a great number of parts, and form unions with a great many other nerves; they have therefore been named *sympatheticus major*, and *sympatheticus medius*." Lectures on Comparative Anatomy, etc., translated by James Macartney, 1802, vol. II, pp. 120–121.

The important experiments of Julian John Cæsar Le Gallois, illustrating the action of the spinal cord, as an independent centre of influences, as well as the philosophical researches of Lobstein which anticipated by more than a quarter of a century, many so-called discoveries in the physiology and pathology of the nervous system, will be more fully considered when we examine the relations of the cerebro-spinal and sympathetic nervous systems.

The first researches of M. Le Gallois, were made on the fœtus in 1806; two years afterwards in 1808. he communicated his first observations to the professors of the faculty of medicine of Paris, and illustrated the effects of decapitation and the functions of the medulla spinalis; on the 2d and 16th of March, 1809, at the request of M. Thouret, dean of the faculty of medicine of Paris, he demonstrated publicly before the same Society of Professors, that the principle of the trunk resides in the medulla spinalis; and the same experiments were afterwards repeated on the 16th of April, before Messrs. Chaussier and Duméril, whom the society had chosen a committee to examine them, and who made their report on the 27th of the same month. The subject was far from being exhausted, and M. Le Gallois soon after began his researches upon the motions of the heart. M. Magendie proved soon after by experiments, that it is by acting upon the medulla spinalis that the poison of the Indians, known under the name of *upas ticuté*, kills animals; and about the same time Mr. Brodie, of the Royal Society of London, instituted experiments to determine the changes of temperature and the state of the secretions in animals kept alive after decapitation. Mr. Brodie asserted, that the decapitated animals, which are kept alive, cool as rapidly, as if they were dead; but upon repeating these experiments, M. Le Gallois found that whilst the temparature is considerably reduced, the reduction is less in these animals in whom the life is preserved by artificial respiration after decapitation, and he pointed out that the inflation of the lungs was one of the principle causes of the refrigeration, together with derangements of the circulation. M. Le Gallois also endeavored to ascertain whether under these circumstances, the formation of the carbonic acid in the lungs is diminished, and with a corresponding alteration of temperature The labors of M. Le Gallois, finally appeared in a connected form in his work entitled "Experiments on the *Principle of Life, and particularly on the Principle of the Motions of the Heart and on the Seat of this Principle;*" a translation of which by Drs. N. C. and J. G. Nancrede, appeared in this country in 1813.

It was not the original object of M. Le Gallois, to explore the cause of the motions of the heart, as he had adopted the theory of Haller on the subject; experiments undertaken with other views led him to the conclusion, that it was impossible for him to understand his own experiments, without determining, whether the nervous power influences the motions of the heart; and if so, in what way it has this effect. A peculiar case of labor excited in him the desire to know how long a full grown fœtus can live without breathing, after all communication between it and the mother has ceased. In order to solve this question by direct experiment, he placed the fœtus of animals in various situations, similar to those in which the human fœtus is occasionally placed, when it ceases to communicate with the mother. When the fœtus suffers decollation from artificial delivery by the feet, he found that the trunk retains its life, and that if hæmorrhage be prevented, by throwing a ligature round the vessels of the neck, it dies in the same time, and with the same symptoms as if without taking off the head, respiration had been interrupted; and what completely demonstrated to him, that a decapitated animal, is in fact suffocated, is that we may at pleasure prolong its existence by inflating the lungs, to supply the place of the natural respiration. M. Le Gallois concluded from these facts, that decollation, proves fatal by destroying the motions of inspiration, and that consequently, the power on which these motions depend is in the brain; but that that on which the life of the trunk depends, is in the trunk itself. Endeavoring by destruction of successive portions of the spinal marrow, to ascertain the precise seat of each of these powers, he found that, that on which the motions of inspiration depend, resides in that part of the medulla oblongata, from which the *eighth pair of nerves*, take their rise; and that on which the life of the trunk depends, in the spinal marrow. By successive destruction of various portions of the cerebro-spinal system, he sought to demonstrate, that it is not by all the spinal marrow, that every part of the body is animated, but only by that portion from which it receives its nerves; so that in destroying any particular part of the spinal marrow, we only destroy life in those parts of the body which correspond to that part. His experiments also illustrated the important fact, that if we interrupt the circulation, in any particular part of the spinal marrow, life is weakened and soon extinguished in all the parts which receive nerves from it. There are therefore two ways of destroying life, in any part of an animal; the one by destroying that part of the spinal marrow from which it receives its nerves, the other by interrupting the circulation in that part of the spinal marrow. He hence concluded that two conditions are necessary to preserve the life of any part of the body; viz: the integrity of the corresponding part of the spinal marrow, and the circulation of the blood, and consequently that we may preserve the life in any part of the animal as long as we can preserve in it these two conditions. We may, for example, preserve the life of the anterior parts, after that of the posterior parts is destroyed, by destroying the corresponding portions of the spinal marrow, or *vice versa*. By numerous vivisections and by carefully destroying different portions of the cerebro-spinal axis, M. Le Gallois arrived at the conclusion, that the power on which the motion of the heart depends, resides in the whole of the spinal marrow, since destruction of any one of its three portions is capable of stopping the circulation; and that each portion of the spinal marrow influences life in two different ways; by the one it is essential to the existence of life in the parts which receive nerves from it; by the other, it preserves it throughout the body in general, by contributing to furnish to the organs which receive nerves from the great sympathetic, and particularly to the heart, the life and power (le principe de force et de vie), necessary to the performance of their functions.*

M. de Humboldt, M. Hallé, and M. Percy, in the report which they made to the class of Physical and Mathematical Sciences of the Imperial Institute of France on the work of M. Le Gallois, regarded the following points, as demonstrated by the experiments repeated before the Committee of the Institute.

1st. That the cause of all the motions of inspiration, has its seat near the part of the medulla oblongata which gives rise to the nerves of the eighth pair.

2d. That the cause which animates each part of the body, resides in that part of the spinal marrow, from which the nerves of that part are derived.

3d. That in like manner it is from the spinal marrow, that the heart derives its life and its powers; but from the whole spinal marrow, and not merely from any particular part of it.

4th. That the great sympathetic nerve, takes its rise from the spinal marrow, and that the particular character of that nerve is to bring every part to which it is distributed under the immediate influence of the whole nervous power.

M. Prochaska placed the sensorium commune, in the brain and spinal marrow conjointly (Opera Minora, tom. ii, p. 51). Before him, however, Marherr, Hartley, and others had been of the same opinion. Prochaska held that the nervous power was generated throughout the whole extent of the nervous system, so that every part derives from its own nerves taken alone, the cause of its life and of its movements (Opera Minora, tom. [illegible], page [illegible]). Prochaska only regarded the sensorium as a central point, where the nerves of feeling as well as those of motion meet and communicate, and which establishes the connection between the different parts of the body. (loc. cit. p. 152.)

On the contrary, M. Le Gallois demonstrated that the spinal marrow is not merely a means of communication, between the different parts, but that from it, the *cause of the life and its power or energy*, and of sensation and of motion of the whole body proceeds. And what proves that M. Prochaska, in announcing his opinion, was far from suspecting the functions of the spinal marrow as demonstrated by Le Gallois, is that he regarded it, with the other physiologists, as a great bundle of nerves, [illegible].

Up to the time of the labors of Le Gallois, the spinal marrow had been considered by most physiologists, with the exception of Unzer, as a large nerve arising from the brain in the same manner, as all those which pass through the foramina of the cranium, and which like them are divided at intervals in order to supply the intervertebral nerves. In short the spinal marrow was considered as a mere bunch of nerves supplying the trunk, as it was often called. The brain therefore was considered as a centre of the nervous power and consequently as the only seat of the [illegible] of life. But Le Gallois clearly demonstrated, in advance of Marshall Hall, and [illegible] suggests that the spinal cord constitutes a distinct system or apparatus, with [illegible] and relations to the muscular system and organs, and capable of receiving and [illegible] and sensitive and reflex acts.

Thus, with reference [illegible] of the brain to the spinal cord, M. Le Gallois [illegible]

"When I move my arm, [illegible] emanates from the medulla spinalis, and not from the brain, but it is the brain which [illegible] the mode appropriated to the purposes for which I make [illegible]. Cold-blooded animals [illegible]. If a salamander be decapitated at the first vertebra, it may continue to live [illegible] it moves its body and limbs with as much force as would be to transport it from [illegible] the same place, and it may be left upon a plate without fear of its escaping. If we [illegible] we perceive that they are all irregular and without design. [illegible] moves its paws in opposite [illegible] if it takes one step forward, it soon takes another backwards. The same thing [illegible] decapitated frogs; they no longer know how to leap, or if they do leap, [illegible] only when their hind legs [illegible]. If they are laid on their backs, they sometimes agitate themselves, seemingly [illegible] they remain in the same position, because they no longer know how to make the [illegible] on their belly. But generally speaking all these animals perform few motions, [illegible] that it ought to be so since [illegible] touch alone can transmit impressions [illegible]

"Reptiles, as the tortoise [illegible] months after decapitation. The [illegible] Redi removed the brain, by [illegible] for several months. It is a well established fact that birds continue alive and [illegible] after their heads have been cut off. The fact has frequently been quoted of the Emperor Commodus [illegible] running in the circus, and [illegible] by cutting off their heads with arrows [illegible]. These animals were not prevented from running as before, and only stopped at the end of the [illegible]. Several physiologists have obtained a like result by decapitating turkeys. Lamétrie Œuvres, Philos [illegible] Boerhaave, [illegible] Tosetti, Mém. sur les part. sens. et irritab. [illegible] M. Cuvier, Leçons Orales [illegible] par Haller. [illegible] Desault relates in his Journal a case where the spinal marrow had been cut [illegible] gunshot, in which the palsy of the inferior extremities did not take place. A like case is found in the [illegible] *Francomartiana*. Authors assert, that a calf [illegible] walk a great ways after decapitation. [illegible] that a woman walked a few steps. Rzaczinski, Hist. Nat. Polon. p. [illegible], that a man was able to hold his sword and brandish it at three different times; that another man struck his breast with both his hands. [illegible] Anthrop. Sublimior, 1751, p. 381. [illegible]

"Decapitation itself is not necessary to produce these phenomena; they are likewise obtained, and in a manner [illegible]

* Experiences sur le principe de la vie notamment sur celui des mouvements du cœur et sur le siège de ce principe [illegible]

still more curious, after the simple section of the medulla spinalis, performed at the occiput. In this case the head is alive, as well as the rest of body, as is evinced by the motions of the mouth and of the eyes. And nevertheless, the animal is exactly in the same state, as if it had been decapitated, viz: no longer able to govern its motions. A situation, truly extraordinary, in which both the head and the body, possess life separately, without being able to exercise any action over each other; the head lives, as if it were without a body, and the body as if it were without a head."

M. Le Gallois, by making successive sections of the brain, from the anterior portion backwards, concluded that the faculty which animals have of regulating their motions, resides in the *medulla oblongata.*

With reference to the mode in which the brain regulates the motions of the body, without furnishing its "*immediate principle*," Le Gallois held, that

> "The brain appears to act upon the medulla spinalis, as the latter acts upon the parts which it animates. It is through the nerves that the medulla spinalis transmits its action, and the nerves appear to be formed of the same substance with the white and medullary part of the brain, and medulla spinalis. I conceive, therefore, that the white part of the medulla spinalis, is composed of nervous filaments, having their origin or termination at one end in the brain and at the other in every part of the medulla, and that it is in the cineritious part of the medulla that both the spinal nerves, and the principle that animates them arise."

In this last supposition, that the spinal nerves were connected with the grey matter of the cord, and that the grey matter of the brain is connected with that of the spinal cord, by means of the nerve tubules, we have not only a philosophical explanation of the results of decapitation and reflex acts, but also an enunciation of the general plan of the structure of certain portions of the cerebro-spinal system, which has more recently been demonstrated to be true by the careful anatomical and physiological investigations of Shroeder, Van der Kolk, Lockhart Clarke and others.

Similar experiments to those of Le Gallois were performed by A. P. Wilson Philip,[*] and Mr. William Clift,[†] the results of which differed chiefly in showing that the action of the heart, although capable of being influenced through the brain and spinal cord, depended rather upon its own ganglionic system, and that of the great sympathetic.

It would have been of interest also, to have traced, in connection with the preceding record, the progress made by various observers, concerning the anatomy and physiology of the organs of sense. Thus, Empedocles appears to have been the first who attempted to explain the nature of sensitive impressions, by the supposition that an elementary affinity existed between exterior objects and the organs of sense. He conceived that there exists in each of the organs a force which governs and attracts from other bodies the molecules similar to their own; thus, the eye being of a resplendent nature, attracts the luminous molecules from bodies; the ear, which is of an airy nature, must attract sonorous particles; the nose has a vaporous, the tongue a humid, and the organ of touch an earthy constitution. Aristotle, Galen and their successors did not make any special modifications in the theory of Empedocles, except to add the hypothesis of spirits, of which they made as many species as there are different senses. These invisible, impalpable spirits were supposed to be secreted by the brain, and to be transmitted to the external organs of sense by the nerves; thus, the visual spirits connected themselves with the organ of sight, where they put themselves in communication with the luminous particles of bodies, and the auditive spirits were communicated to the ear, where they were associated with sonorous particles.

The celebrated mathematician, Kepler, announced in the beginning of the seventeenth century, that the crystalline lens was not, as had been supposed till that time, the seat of vision, but that its function is to refract the rays of light, the image of objects being painted on the retina. Scheiner confirmed and extended these observations, and demonstrated that the expansion of the optic nerve is the essential part of the organ of vision; and many other anatomists submitted the membranes and humors of the eye to careful dissection and examination, and this complicated organ became to be one of the best understood in the organism. Sir Isaac Newton, also, by his researches on light and colors, contributed to the perfection of the theory of the visual function. In like manner, the organ of hearing was studied by Casserius, Duverney and other anatomists; the osselets of the small muscles of the internal ear, and the semi-circular canals were described, the acoustic nerve was followed in its windings and ramifications; and R. Vieussens established the seat of audition in the membrane which lines the drum of the labyrinth.

Mr. Alexander Walker, of Edingburgh, in 1809, first advanced in England the important idea that in the spinal nerves the filaments of sensation issue by one root, and the filaments of motion by the other. Previous to this time, in Great Britain, the theory of Galen had, under the authority of Cullen and the Monroes, continued to prevail, notwithstanding the teachings of Boerhaave, Albinus, Unzer and Prochaska on the Continent.

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[*] Experiments, made with a view to ascertain the principle on which the action of the heart depends, and the relation which subsists between that organ and the nervous system, by A. P. Wilson Philip, physician in Worcester. Philosophical Transactions, 1815, p. 65.

[†] Experiments to ascertain the action of the spinal marrow, on the action of the heart in fishes, by Mr. William Clift. Philosophical Transactions, 1815, pp. 91-96.

Mr. Walker observes, in the "Archives of Universal Science," for July, 1809, published in Edinburgh, p. 172:

> "Medullary action commences in the organs of sense, passes to the spinal marrow by the anterior fasciculi, of the spinal nerves, which are, therefore the nerves of sensation—ascends through the anterior columns of the spinal marrow," etc., and "it descends through the posterior columns of the spinal marrow, which are therefore its descending columns, and expands through posterior fasciculi of all the nerves, which are therefore nerves of volition." * * As in some cases, sensation exists without volition, and as almost all nerves arise by distinct filaments, I am of opinion that whenever a part having both sensation and volition, is supplied from one nervous trunk, that trunk envelopes, both a nerve of sensation and one of volition."

It is evident that the preceding statements involve the idea of double function with the double origin of the spinal nerves: that each of these nerves has two roots and two functions, one of these roots serving for sensation and the other for motion.

Mr. Alexander Walker attributed *sensation* to the *anterior*, and *motion* to the *posterior roots*; and this hypothesis appeared to be supported by general analogy, and to be in conformity with the tenor of all previous observation. That the anterior column of the spinal marrow is continuous with the cerebrum, and the posterior with the cerebellum, had long been admitted by anatomists; and various physiologists, as Willis, Boerhaave and Albinus, had referred the automatic, and Pouteau the automatic and voluntary motions to the cerebellum; and the experiments of Flourens and other physiologists, performed after the enunciation of the theory of Mr. Walker, showed that to the cerebellum belongs the power of co-ordinating or regulating the voluntary movements. Sir William Hamilton also pointed out the parallelism between the relative development of the cerebellum in young animals, and their command over the action of their limbs. In contending, therefore, that the nervous filaments of sensation ascend in the anterior column of the spinal cord to the cerebrum, and the nervous filaments of motion in the posterior to the cerebellum, Mr. Walker proposed the hypothesis which, independently of precise experiment, had the greatest weight of probability in its favor.

Sir Charles Bell, in 1811, in a treatise entitled "*An Idea of a New Anatomy of the Brain, Submitted for the Observation of the Author's Friends*," first propounded the counter doctrine that the posterior roots of the spinal nerves, which have upon them a ganglion, are the sources of sensation: the anterior roots the source of motion; and the primitive fibrils of these roots, after their union, are mingled in one trunk, and thus distributed for the supply of the skin and muscles.

Whilst Sir Charles Bell held the connexion of the cerebrum with the anterior, and of the cerebellum with the posterior column of the spinal cord, he proceeded, however, not on analogies and general probabilities, but by experiments expressly instituted on the roots themselves of the spinal nerves, to establish that to the filaments ascending by the posterior roots belong exclusively the function of sensation; and afterwards, but before any other physiologist, by an ingenious combination of special analogy and experiment, he established the correlative fact, that the filaments descending by the anterior roots are the sole vehicles of voluntary motion.

The same theory was advanced by M. Magendie eleven years later, and J. Müller has claimed for the French physiologist the merit of having first subjected this doctrine to the test of experiment in the case of the spinal nerves. This claim for Magendie is not, however, well founded, for Sir Charles Bell, in his first essay, in 1811, recorded the following experiment on the roots of the spinal nerves: "On laying bare the roots of the spinal nerves, I found that I could cut across the posterior fasciculus of nerves which took its origin from the posterior portion of the spinal marrow, without convulsing the muscles of the back: but that on touching the anterior fasciculus with the point of a knife, the muscles of the back were immediately convulsed."

Sir Charles Bell supposed at first that the anterior roots contained nervous fibres for sensation as well as for motion, while the posterior roots governed the operations of the viscera and the secret operations of the frame, and united the body together. By careful dissections, by conclusive experiments upon living animals, and by a philosophical and wide induction of facts drawn from comparative anatomy, and by observing the modes of origin and distribution of the cerebral nerves, and the effects of sections and pathological lesions upon them, Sir Charles Bell was led to the more correct inference, that the single rooted nerves were connected with the anterior columns of the spinal cord and corresponding parts of the brain, and the anterior roots of the double rooted nerves were exclusively motor, and that the posterior roots of the spinal nerves connected with the posterior columns of the cord, were sensitive. That Sir Charles Bell arrived at this conclusion before M. Magendie, Fodéra, Bellingeri or any other physiologist had taken up the inquiry, rests upon the evidence contained in the various papers which he published in the transactions of the Royal Philosophical Society of London, an analysis of which we will give, and also upon the statements contained in Mr. John Shaw's Manual of Anatomy, published September, 1821, and in several papers by Mr. Shaw, (a pupil of Mr. Bell's) which appeared in the Quarterly Journal of Science, December, 1821, and March, 1822, and in the Medico-Chirurgical Transactions, April, 1822.

Mayo and Magendie both published memoirs in August, 1822, upon the sensitive and motor nerves, and these and subsequent works confirmed the doctrine of Mr. Bell.

The claims of Sir Charles Bell to the important discovery of the distinct seat of motion and of sensation in the spinal nerves, have been acknowledged by Sir William Hamilton, and by a number of English, French and German physiologists; but the claims of Magendie to the same discovery, which were advocated by a writer in the London Medical and Physical Journal, 1829, Vol. LXII., p. 532. and by Elliotson, (Human Physiology, 1840. p. 465), have been recently ably supported by Bernard, (Rapport sur le Progrès et la Marche de la Physiologie Générale en France, Paris, 1867, pp. 12 and 154), and by Professor Austin Flint, Jr., (Historical Considerations Concerning the Properties of the Roots of the Spinal Nerves; Quarterly Journal of Psychological Medicine, New York, Vol. II., p. 625 et seq; Journal de l' Anatomie, Paris, 1868, Tome V., p. 520 et seq., and p. 575 et seq).

However fully we may be disposed to admit the claims of Sir Charles Bell, at the same time great credit must be accorded to Magendie for having independently and by well devised and accurate experiments established the same doctrine. Magendie, in August, 1822, (Expériences sur les Fonctions des Racines des Nerfs Rachidiens; Journal de Physiologie, Paris, Tome II, p. 276 et seq), published his first experiments on the functions of the roots of the nerves, made upon living animals, and announced the conclusion "that the anterior and the posterior roots of the nerves which arise from the spinal cord have different functions; that the posterior seem more particularly devoted to sensibility, while the anterior seem more especially connected with motion."

In a subsequent number of the same journal, Magendie states that when he published the account of his experiments, he supposed that he was the first who had thought of cutting the roots of the spinal nerves; but he was undeceived by a letter from Mr. Shaw, who stated that Charles Bell had divided the roots thirteen years before. Having afterwards received from Mr. Shaw a copy of Bell's Essay, ("Idea of a New Anatomy of the Brain,") Magendie observes:

> "It is seen by this quotation from a work which I could not be acquainted with, inasmuch, as it had not been published, that Mr. Bell, led by his ingenious ideas concerning the nervous system, was very near discovering the functions of the spinal roots; still the fact that the anterior are devoted to movement, while the posterior belong more particularly to sensation, seems to have escaped him; it is then, to having established this fact in a positive manner that I must limit my pretensions." Journal de Physiologie, Paris, 1822, tome. ii, p. 371

Magendie, in 1823, extended his researches to the cord itself, and demonstrated that the anterior columns were motor, and the posterior columns sensitive, (Journal de Physiologie, Paris, 1823, Tome III., p. 153, et seq.); and the name of this distinguished physiologist is chiefly connected with the discovery of the seat of sensation and motion in the different columns of the spinal cord.

Mr. Alexander Shaw, in his "*Narrative of the Discoveries of Sir Charles Bell in the Nervous System*," published in 1839, states that a mistake of Sir Charles Bell's, in an experiment which he had made to prove his doctrine, was discovered through the joint labors of M. Magendie and Mr. Mayo.

M. Magendie, in 1822, asserted that the posterior column of the spinal cord, and the posterior roots of the nerves, supplied sensation principally; the anterior principally motion; but that the latter were not wholly devoid of sensitive power. In the experiments of M. Magendie, the application of galvanism to the posterior roots of the spinal nerves, after their separation from the spinal cord, excited contractions of the muscles, though they were but feeble; while the same stimulus applied to the anterior roots, gave rise to violent muscular spasm (*J. de* Physiologie, II., 276, Desmoulins et Magendie, Anat. Physiol. des Systems Nerveux, Paris, 1825, p. 777).

Muller remarks that Fodéra's experiments were accompanied with such contradictory symptoms, that it is inconceivable how he could put them forth as confirmatory of M. Magendie's observation. Neither can the claim of the Italian Physiologist, Bellingeri, be maintained, although both investigators appear to have labored and achieved similar results without any knowledge of each other's experiments and researches. The publications of Bellingeri were made in 1818, 1823. 4, and 5, and 1833.

The treatise of Professor Bellingeri, "*De Medulla Spinalis*," published in 1823, contains important observations on the structure and functions of the spinal cord. In this work he announced that the central part of the cord is composed of cineritious matter in the form of two segments of circles convex towards each other, forming four projections, which are called cornua. The white, or medullary matter, is in the form of six cords or strands, two anterior, divided from each other by a deep furrow, and one on each side of the cineritious matter. These cords or strands are supposed to be connected with different parts of the encephalon, the anterior with the cerebrum, the posterior with the cerebellum, and the lateral cords with the restiform process; these are termed respectively, the cerebral, the cerebellic, and the restiform parts of the cord. The white or medullary matter he described as fibrous, and the gray, or cineritious matter, as globular. Blainville, without apparently any knowledge of Bellingeri's observations, adopted an opinion of the structure of the cord, in many respects similar, although less minutely developed; and the same appears to have been the case with Rolando.

Bellingeri's experiments (Exp. in Nerv. Antigonismum, 1824; Exp. Physiol. in Med. Spin. 1825), led him to conclude that the anterior pillars are more immediately connected with the flexion of the limbs, and the posterior with their extension, and he applied this doctrine to the cerebrum and cerebellum themselves, in consequence of their supposed connection with the two parts of the column. Magendie had suggested the idea that the two portions of the nervous system were connected respectively with the pillars of which the cord is composed. It will be seen by a comparison of these views of Bellingeri with those of Sir Charles Bell, that there is a material difference in some respects and marked coincidence in others; and the conclusion is also justified, that although Sir Charles Bell may have been anticipated on some points, by the Italian physiologist, yet when he performed his experiments and published an account of them, he was entirely unacquainted with those of Bellingeri.

The experiments of Bell and Magendie, were carefully repeated in Germany by M. Schoeps, on many animals, but the results obtained were doubtful and uncertain. Professor J. Müller, of the University of Berlin, performed similar experiments in 1824, without success; subsequently whilst engaged in researches on the nervous system, he was induced to perform a new series of experiments on rabbits, on a different plan. Professor Müller conceived that the mode in which the investigation had previously been conducted was deceptive, from the circumstance that many animals, especially rabbits, are so much frightened by the first steps of the experiment, before they have suffered any considerable injury, that the most violent irritation of the skin, not even pinching and cutting it, causes them to manifest any pain. The slightest irritation of a nerve, when tense and stretched, with a needle, excites contractions in the muscles to which it is distributed. If then, the posterior roots of the spinal nerves are merely sensitive, and not indued with motor power, they ought, when irritated with the needle, to excite no contractions of the muscles: while these ought to ensue from the irritation of the anterior roots. That he might perceive the most trifling twitchings. Professor Müller laid bare the muscles of the posterior extremities; experiments thus performed yielded no certain results, since the shock produced in opening the spinal column had given rise to tremors of the muscles, which rendered the results of the further part of the experiment unsatisfactory. After many unsuccessful attempts to verify M. Magendie's assertion, Müller began to doubt the possibility of obtaining a decided and satisfactory result from all such experiments. Desmoulins and Magendie themselves, had merely said, in the one case *nearly all sensation*, in the other, *nearly all power of motion is lost*. The theory of Bell appeared still to require demonstration; even Magendie had not decided it satisfactorily; and it seemed to be impossible to decide it with certainty in the higher animals. Not only Müller, but Prof. E. H. Weber, held the opinion, that the theory of Bell, had not been properly established by experiment. The thought happily occurred to Professor Müller, of performing the experiments upon frogs. These animals are very tenacious of life, and long survive the opening of the vertebral canal; their nerves also retain their excitability for a very considerable time. and the large roots of the nerves of the posterior extremities run a long distance within the cavity of the spine before uniting. The result was most satisfactory; and the experiments of Professor Müller proved conclusively that *it is quite impossible to excite muscular contractions in frogs by irritating mechanically, the posterior roots of the spinal nerves: while on the other hand, the slightest irritation of the anterior roots, immediately gives rise to very strong actions of the muscles.* As long as both roots of the nerves are in connection with the spinal cord, the traction experienced by the cord itself, when the posterior roots are raised, may cause the production of muscular twitches in the limbs; such effects however, are quite independent of the action of the posterior roots, and depend solely on the irritation communicated to the anterior roots, by the spinal cord, in consequence of the mechanical violence which this has suffered. Hence, if the latter roots have been previously divided, no mechanical irritation of the spinal cord itself, or of the posterior roots connected with it, excites the slightest muscular contractions.

The experiments of Professor Müller, with the galvanic stimulus of a single pair of zinc and copper plates were equally conclusive. *The application of galvanism to the anterior roots of the spinal nerves, after their connection with the cord is divided, excites violent muscular twitchings; the same stimulus applied to the posterior roots, is attended with no such effect.* This result was remarkable, for Müller had imagined that, although the posterior roots are endowed with sensation merely, they might still conduct the galvanic fluid to the muscles, and when a powerful galvanic pile is employed, this is inevitably the case (as in Magendie's experiments). the strong galvanic current being conducted by the posterior root of the nerve as by any animal substance. The stimulus of a pair of plates, however, while it causes the anterior roots of the nerves to give rise to muscular contractions, has no such influence when applied to the posterior roots. In this experiment, it is necessary to be very cautious that the plates are brought into contact with no other part than the nerves. When the experiments were performed on frogs in the manner adopted by Sir Charles Bell, and M. Magendie, the results were as decided as in those just detailed. If in the same frog, the three posterior roots of the nerves going to the hinder extremity, be divided on the left side, and the three anterior roots on the right side, the left extremity will be deprived of sensation, the right of motion. If the foot of the right leg, which is still endowed with sensation but not with the power of motion, be cut off, the frog will give evidence of feeling pain by movements of all parts of the body, except the right leg itself, in which he feels the pain. If on the contrary, the foot of the left side, which has the power of motion, but is deprived of sensation, is cut off, the frog does not feel it. This experiment is the most striking of all, and the result is decisive, because, on account of the small number and large size of the roots of the nerve going to the posterior extremity in the frog, we can be certain that all are divided. (Elements of Physiology by J. Müller, M. D. vol. I, pp. 692-5). The foregoing experiments of Professor J. Müller, left no doubt as to the correctness of the theory of Sir Charles Bell.

Sir Charles Bell, in his article "*On the Nerves, giving an account of some experiments on their structure and functions, which lead to a new arrangement of the system,*" communicated to the Philosophical Society, by Sir Humphrey Davy, and read July 12, 1821,[*] limited the inquiry to the nerves of respiration. According to the conception of Sir Charles Bell, the respiratory nerves, form a system of great extent, *comprehending all the nerves, which serve to combine the muscles employed in the act of breathing and speaking.* He endeavored to show, that some hundred muscles employed in the acts of breathing, coughing, sneezing, speaking and singing, are associated, and brought into harmony by the respiratory nerves. Sir Charles Bell, announced and sustained by experiments upon animals, the following propositions:

When we minutely and carefully examine the nerves of the human body, and compare them with those of other animals, a very singular coincidence is observed between the number of organs, the compound nature of their functions, and the number of nerves which are transmitted to them. No organ which possesses only one property or endowment has more than one nerve, however exquisite the sense or action may be; but if two nerves coming from different sources are directed to one part, this is a sign of a double function performed by it. If a part or organ have many distinct nerves, we may be certain, that instead of having mere accumulation of nervous power, it possesses distinct powers, or enters into different combinations, in proportion to the number of its nerves.

The nerves of all creatures may be divided into two parts or systems; the one simple and uniform, the other irregular and complex, in proportion to the complexity of organization. Thus when an animal is endowed with mere sensation and locomotion, when there is no central organ of circulation, and no organ of respiration but what is generally diffused over the frame, the nerves are extremely simple; they consist of two cords, running the length of the body, with branches going off laterally to the several divisions of the frame. Here no intricacy is to be seen, no double supply of nerves is to be observed, but each portion of the frame has an equal supply; and the central line of connection is sufficient to combine the actions of the muscles, and to give them the concatenation necessary to locomotion. There is the same uniform and symmetrical system of nerves in the human body, as in the leech or worm; although obscured by a variety of superadded nerves. These additional nerves belong to organs, which tracing the orders of animals upwards, are observed gradually to accumulate until we arrive at the complication of the human frame. These nerves, additional and superadded, to the original system, do not destroy, but only obscure that system; and accordingly, when we separate certain nerves, the original system of simple constitution is presented even in the human body. According to Sir Charles Bell, the *nerve of the spine*, the *tenth or sub-occipital nerve*, and the *fifth or trigeminus* of the system of Willis, constituted this *original and symmetrical* system. All these nerves agree in these essential circumstances; they have all double origins; they have all ganglia in one of their roots: they go out laterally to certain divisions of the body; they do not interfere to unite the divisions of the frame; they are all muscular nerves, ordering the voluntary motions of the frame; they are all exquisitely sensitive; and the source of the common sensibility of the surfaces of the body; when accurately represented on paper, they are seen to pervade every part; no part is without them; and yet they are symmetrical and simple, as the nerves of the lower animals. If the nerves be exposed in a living animal, those of this class exhibit the highest degree of sensibility; while on the contrary nerves not of this original class or system, are comparatively so little sensible, as to be immediately distinguished; in so much that the quiescence of the animal suggests a doubt whether they be sensible in any degree whatever. If the *fifth nerve*, and the *portio dura of the seventh*, be both exposed, on the face of a living animal, there will not remain the slightest doubt in the mind of the experimenter which of these nerves fosters sensibility. If the nerve of this original class be divided, the skin and common substance is deprived of sensibility; and if a nerve not of this class be divided, it in no measure deprives the parts of their sensibility to external impressions.

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[*] Philosophical Transactions, 1821, pp. 398, 424.

The nerves which connect the internal organs of respiration with the sensibilities of remote parts, and with the respiratory muscles, are distinguished from those just described, by many circumstances: thus, they do not arise by double roots; they have no ganglia in their origins: they come off from the *medulla oblongata* and the upper part of the spinal marrow; and from this origin, they diverge to those small remote parts of the frame which are combined in the motion of respiration.

According to Sir Charles Bell, the *Par vagum*, (the eighth of Willis, the pneumogastic nerve of the modern French physiologist,) which goes off from the common origin of the respiratory nerves, at the lateral part of the *medulla oblongata*, associates the larynx, the lungs, the heart, and the stomach. These organs, however, are at the same time supplied with nerves from other sources. Comparative anatomy sustains the inference that this nerve is not essential to the stomach, as it does not exist but when there are hearts and lungs to associate with a muscular apparatus of respiration. That the stomach must be associated with the muscular apparatus of respiration, as well as the lungs, is obvious, from the consideration of what takes place in vomiting and hiccough, which are actions of the respiratory muscles excited by irritation of the stomach. Sir Charles Bell, illustrated by a series of vivisections, the fact that sneezing and coughing are entirely confined to the influence of the respiratory nerves, and that the peculiar expression in sneezing, results from an impression on the respiratory nerves, and that the muscles of the face are drawn into sympathy, solely by the influence of the respiratory nerve of the face.

Sir Charles Bell complains of the loose manner in which the anatomy and physiology of the sympathetic nervous system had been treated; the connections of this nerve or system of nerves, being universal, it had been supposed that it was the cord through which the relations of the eye, nose, face, throat, diaphragm, &c., were established; whereas this distinguished anatomist and physiologist demonstrated that the combination is effected solely through these nerves, which from their general or leading function are called the respiratory nerves.

Sir Charles Bell, in his Second Article (Phil. Trans. 1822, pp. 284, 312.) "On the nerves which associate the muscles of the chest in the actions of breathing, speaking and expression," read before the Philosophical Society, May 2d, 1822, affirms that, whenever in examining the comparative anatomy of animals, we find ribs rising and falling by respiratory muscles, we have a *medulla spinalis* and the distinction of *cerebrum* and *cerebellum*: and experiment and observation prove that the seat of that power which controls the extended act of respiration, is in the lateral portions of the *medulla oblongata*, from which it is combined through certain respiratory nerves which pass out from the neck, and also downwards by corresponding columns of the spinal marrow, to the intercostal nerves. *The medulla oblongata and spinalis*, are composed of columns of nervous matter, which from the different powers of the nerves, as they arise from the one or the other of these columns, possess distinct properties. In animals that breathe by ribs, and a numerous class of muscles, and which animals have a spinal marrow, a column of nervous matter is embraced between the anterior and posterior virgae of that body, and this portion may be traced downwards between the roots of the spinal nerves. From the upper part of this column, where it begins in the *medulla oblongata*, the several nerves proceed which form the respiratory system of Bell. The power of the regular succession of intercostal and lumbar nerves, as far as they regulate the respiratory actions, proceeds from the connection of the roots of these nerves with this column which is continued downwards, and which throughout can be distinguished from the rest of the spinal marrow.

Sir Charles Bell concludes this paper with valuable observations upon the relations of the respiratory system of nerves to certain diseased states, and dwells upon the fact that the respiratory nerves are distinguished from the other nerves by retaining their power longer, that they are alive to impression, and can be made to produce convulsions in the muscles they supply, after the other muscles are dead to the application of stimuli. These facts sustain the conclusion that the respiratory nerves have a centre and a source of power different from that of the voluntary nerves.

The respiratory nerves, so peculiar in relation and function, are differently influenced by disease from the other division of the nervous system; their functions are left entire when the voluntary nerves have ceased to act, and they are sometimes strangely disordered, while the mind is entire in all its offices, and the voluntary offices perfect. Thus in Tetanus, the voluntary nerves are under influence, and the voluntary motions locked up in convulsions: in Hydrophobia, the respiratory system is affected, and hence the convulsions of the throat, the paroxysms of suffocation, the speechless agony, and the excess of expression in the whole frame, while the voluntary motions are free.

Sir Charles Bell, in this paper, justly observes, that the confusion between vital and voluntary nerves, the combining, the par-vagum and sympathetic nerves together, and the exclusion of the *portio dura* of the seventh nerve, the spinal accessory nerve, and the external thoracic nerve, from their natural classification with the diaphragmatic or phrenic, has given rise to very vague theories, and occasioned very inaccurate statements of pathological facts.

By these experiments and researches of Sir Charles Bell, the respiratory system of nerves has been extricated from the seeming confusion in which it lay encumbered, and he demonstrated that it was superadded to the system of mere feeling and motion, which is common to all animals. In man, through the respiratory system of nerves, is superadded to the original animal nature, higher powers or agency, corresponding to his condition of mental superiority. These nerves are not the organs of breathing merely, but of natural and articulate language also, and adapted to the expression of sentiments in the workings of the countenance, and of the breast, that is by signs, as well as by words; so that the breast becomes the organ of the passions, and bears the same relation to the development of sentiments as the organs of the senses do to the ideas of sense.

Sir Charles Bell * concludes the second part of his paper on the "Nerves of the Orbit," read before the Philosophical Society, in 1823, with some general observations, on the views held by the ancients relating to the functions of the nervous system, and at the same time he took occasion to criticise adversely the work of Bichat and the experiments of M. Le Gallois; the following observations, however, appear to possess the most interest in their connection with our present introduction to the study of nervous diseases:

> "So far is it from being true that ganglia cut off sensation, that I have ascertained, and proved by experiments, that all the nerves, without a single exception, which bestow sensibility from the top of the head to the toe, have ganglia on their roots; and those which have no ganglia are not nerves of sensation, but are for the purpose of ordering the muscular frame. * *
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> "This notion of a fluid moving backwards and forwards in the tubes of the nerves, equally adopted to produce motion and sensation, has perpetuated the error, that, the different nerves of sensation are appropriated to their offices by the texture of their extremities, that there exists a certain relation between the softness of the nervous extremities, and the nature of the bodies which produce an impression on them. On the contrary, every nerve of sense is limited in its exercise, and can minister to certain perceptions only. Whatever may be the nature of an impulse communicated to a nerve, pressure, vibration, heat, electricity, the perception excited in the mind, will have reference to the organ exercised, not to the impression made upon it."

In 1826, Sir Charles Bell published his paper "*On the Nervous Circle, which connects the voluntary muscles with the Brain.*"† The following analysis, presents the main points of his theory, as well as the facts which he claims to have established.

In the preceding papers which Sir Charles Bell had addressed to the Philosophical Society on the arrangement of the nerves of the human body, he had proceeded on a comparison of the nerves of the spinal marrow with the nerves of the encephalon. It was shown that the former were compounded of filaments possessing different powers, having several properties or endowments, and proceeded to their destination without intricacy. Unless Sir Charles Bell had discovered the composition of the roots of these nerves, he would have continued to suppose, that one nerve was simple in its structure, and yet capable of bestowing the very different properties of motion and sensation; but having satisfied himself that the roots of the spinal nerves have distinct powers, he followed up the columns of the spinal marrow, and with a knowledge of the composition of these nerves as a key, he examined the different properties of the nerves of the encephalon. In the head the nerves arise simply and diverge to their destinations, without the close compact or union which the spinal nerves form; and, accordingly, the anatomy of the nerves of the brain offered satisfactory proof of their uses or functions.

In the next place he demonstrates, that every muscle has two nerves of different properties supplied to it. This fact could not have been ascertained by an examination of the spinal nerves alone, because of the intimate union of all their fibres, and consequently, he had recourse to the nerves of the head. By prosecuting these inquiries which led to the distinction of the different classes of nerves, he reached the conclusion, that, *where nerves of different functions, take their origin apart and run a different course, two nerves must unite in the muscles, in order to perfect the relations between the brain and muscles.* In his first paper, the difference had been shown in the nerves of the face; by dividing one nerve, sensation was destroyed, whilst motion remained; and by dividing the other, motion was stopped, whilst sensibility remained entire. The muscles have no connection with each other, they are combined by the nerves; but these nerves, instead of passing betwixt the muscles, interchange their fibres before their distribution to them, and by this means, combine the muscles into classes. The question, therefore, may thus be stated; why are nerves, whose office it is to convey sensation, profusely given to muscles in addition to those motor nerves, which are given to excite their motions? and why do both classes of muscular nerves form plexuses?

> "Expose the two nerves of a muscle; irritate one of them, and the muscle will act; irritate the other, and the muscle remains at rest. Cut across the nerve which had the power of exciting the muscle, and stimulate the other.

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* On the motion of the Eye by Sir Charles Bell, Phil. Trans. 1823, p. 166, p. 289. On the Nerves of the Orbit. Phil Trans. 1823, p. 166–186.

† Philosophical Transactions, 1826, p. 163.

> which is undivided—the animal will give indication of pain; but although the nerve be injured so as to cause universal agitation, the muscle with which it is directly connected, does not move. Both nerves being cut across, we shall still find that by exciting one nerve the muscle is made to act, even days after the nerve has been divided; but the other nerve has no influence at all.
>
> "Now it appears the muscle has a nerve in addition to the motor nerve, which being necessary to its perfect function, equally deserves the name of muscular. This nerve, however, has no direct power over the muscle, but circuitously through the brain, and by exciting sensation it may become a cause of action.
>
> "*Between the brain and the muscles there is a circle of nerves; one nerve conveys the influence from the brain to the muscle another gives the sense of the condition of the muscle to the brain.*
>
> "If the circle be broken by the division of the motor nerve, motion ceases; if it be broken by the division of the other nerve, there is no longer a sense of the condition of the muscle, and therefore, no regulation of its activity."

Sir Charles Bell, in his important article, "*On the functions of some parts of the brain and on the relations between the brain and nerves of motion and sensation,*" received by the Royal Philosophical Society, March 3d, and read May 15th, 1834, and published in the Philosophical Transactions of 1834, pp. 471-483, extends the doctrine of a *nervous circle* cr *reflex action*, so clearly announced in the preceding paper, to the spinal cord, thus announcing the doctrine claimed and elaborated by Marshall Hall. Thus Sir Charles Bell, says:

> "The spinal marrow has much resemblance to the brain, in the composition of its cineritious and medullary matter, and in the union of its parts. In short, its structure declares it to be more than a nerve, that is, it possesses properties independent of the brain. Another consideration presses upon us. Where are the many relations existing between the different parts of the frame, and necessary to their combined actions established? There must be a relation between the four quarters of an animal. If the muscles of the arm or of the lower extremities are combined through the plexus of nerves in the axila, and in the loins, what combines the muscles of the trunk, and more especially, what joins the extremities together in sympathy? That their combined motions and relations are not established in the brain, the phenomena exhibited in stimulating the nervous system of the decapitated animal sufficiently evince. They must, therefore, depend on an arrangement of the fibres somewhere in the spinal marrow, Comparative Anatomy countenances this idea, since the motions of the lower animals are concatenated independent of a brain, and independently of the anterior ganglion which in some respects gives direction to the volition of these animals."

In the last article "On the Nervous System," published in the Philosophical Transactions in 1840, (p. 245), by Sir Charles Bell, he states that he was induced to commence the experiments on the roots of the nerves of the spine in 1810, by the following considerations. Why do six nerves pass into the orbits? Why should three nerves penetrate the coates of the eye? Why should some of these nerves have ganglions on them and others none? If it be correct, that the brain is the officina spiritum, and gives out a common influence through the nerves, what is the meaning of the intricacy in the distribution of the nerves? He gives at length the argument, drawn from anatomy, physiology, and pathology which led to his experiments and discoveries.

From the preceding statement, it is evident, that the brilliant discoveries of Sir Charles Bell, were not the results of accident. On the contrary his experiments on the spinal marrow and roots of the nerves, were not undertaken until after long consideration and much minute dissection. His lectures on the nervous system extended beyond what was customary in the courses delivered in London, and not trusting to preparations, minute dissections were made for each lecture; and to afford time for these, discussions on the physiology and pathology of the nervous system were thrown into the demonstration.

In making two distinct systems of the nerves arising from the spinal column, it was never the intention of Sir Charles Bell, to convey the idea that they were cut off from the sensorium.

The connection of the brain with the spinal marrow, formed a distinct subject of inquiry, and Sir Charles Bell unfolded his views, on this important subject, most fully in the Philosophical Transactions of 1834 and 1835, and we shall conclude this account of his discoveries, with an analysis of his papers[*] on the functions of some parts of the brain, and on the relations between the Brain and Nerves of Motion and Sensation.

The difficulties which attend the investigation of the structure and functions of the brain, are manifested by the ineffective labors of two thousand years, and from the extraordinary and contradictory results often experienced in experimenting upon an organ of such delicate constitution as that which ministers to sensibility and motion, and which is subject to change in every impression conveyed through the senses. This remarkable susceptibility, is exemplified by the extraordinary results, such as violent convulsions and excruciating pain, arising from causes which appear quite inadequate: the presence of a minute spicula of bone which has penetrated to the brain, will at one time be attended with no consequence at all, at another it will occasion a deep coma, or loss of both sensibility and motion, and symptoms apparently as formidable will be produced by slight irritation on remote nerves:—water in the brain, which has free access to all the cavities of the brain, and which to all appearance both presses equally, and if it irritate must irritate equally, will have the effect of rendering one side of the body paralytic and of convulsing the other with incessant motion. Another source of error, especially to the experimenter on the brain, is the disturbance of its circulation for the brain depends more directly than any other organ on the condition of the circulation within it; by the mere raising of the skull, as a necessary preliminary to most experiments, there is an immediate disturbance of the circulation, which of itself may be attended with insensibility or convulsions. Another source of error, was the obscurity which hangs over the whole subject, for although the brain be divided naturally into distinct masses, not one of these grand divisions had yet been distinguished by its function, and there was not even an opinion as to their relative importance. And if the enquirer be not critically guarded, he is liable to erroneous conclusions, by the fact, that whole masses of the brain may be destroyed by disease, or actually removed with impunity, that is to say, without any immediate influence on the mind, or on the power of motion or sensibility; yet the very slightest general impression on the brain, will in the instant deprive the individual both of sense and motion.

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[*] Philosophical Transactions, 1834, pp. 471–483; 1835, pp. 255–260.

The truth of Sir Charles Bell's discovery, that nerves have distinct functions, and not a common quality, and that the sensitive and motor roots of the nerves spring from different sources, being universally admitted, it appeared to him, to be a very rational mode of inquiry to follow these nerves into the brain, and to observe the tracts of nervous matter from which they take their origin. On this plan he proposed to demonstrate that *sensibility and motion belong to the cerebrum,—that two columns descend from each hemisphere—that one of them, the anterior, gives origin to the anterior roots of the spinal nerves, and is dedicated to voluntary motion—and that the other (which from its internal position is less known) gives origin to the posterior roots of the spinal nerves, and to the sensitive roots of the fifth nerve,—and is the column for sensation.* And further, that the *columns of motion which come from different sides of the cerebrum join and decussate in the medulla oblongata,—that the columns of sensation also join and decussate in the medulla oblongata.* Finally, that these *anterior and posterior columns bear in every circumstance a very close resemblance to one another,*—that is to say, *the sensorial expansions of both are widely extended in the hemispheres: they pass through similar bodies towards the base of the brain, and both concentrate and decussate in the same manner, thus agreeing in every respect, except in the nervous filaments, to which they give origin.*

Of the Striated Septa in the Medulla Oblongata and Pons Varolii. Superior importance should be given to these tracts of striated matter which descend from the brain to the spinal marrow, since they are obviously the lines of communication, between the organ of the mind and the frame of the body. But these longitudinal tracts are separated by certain plates of fibrous matter which go directly transverse, are very regular, very easily demonstrated, and although important in themselves, are particularly useful in establishing the natural distinctions or boundaries between the columns, which descending from the encephalon constitute the medulla oblongata and the spinal marrow.

The pons varolii, or nodus cerebri, through which the filaments of the brain pass, from its intricate structure may be taken as a key to the composition of the brain. By careful dissections, Sir Charles Bell traced these great tracts or courses of fibres into the crus cerebri, an anterior one for motion, a posterior one for sensation, and a middle one, which he calls the tract of the corpus olivari. In the light of his dissections, it was impossible for him to consider the medulla oblongata as the mere commencement of the spinal marrow; it has a peculiar structure and distinct functions; it is the body formed by the convergence of the great tracts of the cerebrum, where these tracts respectively meet and decussate; in it the tract of the corpus olivari is joined to those of motion and sensation. Below the medulla oblongata, the spinal marrow commences, or rather is prolonged from it, but it is constituted with a distinct arrangement of its columns. On each side it receives these columns from the cerebrum, besides those which come down from the cerebellum, under the name of corpora restiforma, to form its posterior part, and these columns enter into relations which do not exist above. The anatomist cannot fail to observe the remarkable correspondence in the structure and course of the two grand tracts or divisions of the crus cerebri, which descending, form so large a portion of the spinal marrow. Tracing them from the brain, we find both converging from the periphery of the hemisphere; both entering masses of cineritious matter, emerging alike and approaching but not absolutely joining; both contracting into narrow pyramidal columns; both having corresponding decussations, and only distinguished at last by one of them giving origin to the motor nerves, and the other to the sensitive.

The origin of the posterior roots of the spinal nerves—The posterior roots of the first, and consequently of all the spinal nerves, are derived from that posterior column which descended from the posterior division of the crus cerebri, and they are thus placed in the same relation as the anterior roots, with respect to the decussation of the prolonged medullary matter of the cerebrum.

It has been observed by anatomists from time to time, that the nerves of the encephalon come off in a direction ascending from the spinal marrow; according to Sir Charles Bell, there can be no doubt that the sensitive root of the fifth ascends, and that it has its origin in the spinal marrow rather than in the brain.

Sir Charles Bell concludes his paper, published in 1834, with practical observations and applications to pathological phenomena.

In his continuation of the preceding paper, published in the Philosophical Transactions of

1835, Sir Charles Bell gives the following addition to his views as to the function of the cerebellum.

As long as he entertained the belief that the nerves of sensation, that is to say the posterior roots of the spinal nerves, came from the posterior columns of the spinal marrow, and consequently from the cerebellum, he found his progress barred, for it appeared incomprehensible that motion could result from an organ like the cerebrum, and sensation from the cerebellum, for there was no agreement between them. They conformed neither in size, shape, nor subdivisions. Sensation and volition are necessarily combined in every action of the frame. Although these influences of whatever nature they be, are projected in different directions, and belong to distinct filaments, they must be finally conjoined and in union. The anatomy conforms to this idea; the cords of communication between the seat of volition and the organs of the body proceed from a centre, run parallel, undergo similar changes, and are blended in their ultimate distribution as in their central or cerebral relations.

In his article published in the Philosophical Transactions of 1840, Sir Charles Bell records the important fact, that since he had reason to conclude that the columns of the spinal marrow, and the roots arising from them, were distinct in function, he had met with no instance of disease, in the bodies of the vertebra, attended by paraplegia, in which the muscular power of the limbs has not been the first affected: in all, the defects of motion has been greater than the diminution of sensibility; in some the motion of the limbs has been lost, whilst the sensibility has been exquisitely acute. These facts he regarded, as accounted for, by the motor roots of the spinal nerves being more directly exposed to the influence of the inflammation seated in the bodies of the vertebra, than the posterior roots of sensation, which arise more remote from the disease. Whilst expressing his unwillingness to enter on so great a subject as the influence of the cerebellum, and of the posterior column of the spinal marrow which descends from it; Sir Charles Bell took occasion in the last of his papers published by the Royal Society, to reiterate the opinion, that important as these parts must be in the economy, there are no facts to countenance the belief, that they are directly connected with the functions of motion and sensibility. Indeed he affirms, that the posterior column of the spinal marrow has been softened to a degree, which we must suppose inconsistent with the continuance of its functions; and yet sensibility has been entire. But he does not let this fact militate against his conclusions, for *the column in the spinal marrow which gives rise to the sensitive roots, is posterior to that from which the motor roots arise: but is not the posterior portion of the spinal marrow*

Mr. George Newport,* in an admirable series of investigations, upon the structure of the nervous system in the lower animals, endeavored to demonstrate whether the discoveries of Sir Charles Bell with reference to the nervous system in vertebrate animals, viz: the endowment of different parts of the spinal column, with different properties ministering to different functions, volition, sensation, and involuntary motion, were applicable to the nervous system of invertebrate animals.

The nervous system of crustacea, according to Mr. Newport, consists of two longitudinal cords, corresponding to the two halves of the body, united at certain distances by ganglia: these cords are double, each being composed of two tracts, lying one over the other, analogous to the motor and sensitive tracts in the spinal column of vertebrata.

Mr. Newport records the interesting observation, that while engaged upon the anatomy of the lobster, he obtained a large living specimen, which although apparently vigorous and healthy, appeared to suffer but little pain when pricked or pinched, and was of a much lighter color than usual, its whole covering being quite blue, instead of the usual blackish purple. Upon killing the animal and examining its spinal cords, the motor columns and nerves were of the usual size and appearance, but all the ganglia of the sensitive columns, particularly those in the post-abdominal region, were exceedingly small, and each enclosed only a very small nodule of gray matter. Mr. Newport was led by this observation, to ask, "whether we may not infer that the degree of sensation in nerves belonging to the spinal column, very much depends upon the size of the ganglia, and the quantity of gray matter they contain?"

Mr Newport, in his paper, *On the Respiration of Insects*, observes that the inverted position of the nervous cords in insects and other invertebrata has not a little confounded the right understanding of the analogy which exists between the nervous cords of vertebrate and invertebrate animals, and has given an appearance of probability to the opinion entertained by some anatomists that the cords in the invertebrata are not analogous to the spinal cord of vertebrata, but to the sympathetic system. Even some of those who now believe that these cords are really analogous to the cerebro-spinal system of the higher animals, can hardly reconcile this opinion with the fact of their being situated along the ventral instead of the dorsal aspect of the body. The reason for this change of position of the cords in invertebrata appears to be partly to protect the cords themselves and partly, that the nerves may be supplied to the limbs without having to travel round the sides of the body, and thereby be exposed to the hazard of injury which they would be, were they situated along the dorsal surface as in the vertebrata. But notwithstanding this change of position of the cords in invertebrata, since we now find that they are composed each of two tracts, as in vertebrate animals—it is important to observe that these two cords, and the tracts of which they are composed bear the same relative position to the viscera, and to the exterior of the body, as in man and other vertebrata. Thus the cord which runs along the ventral surface in articulata, has its motor tract nearest the viscera, or most internal, the same as in the human subject; while the sensitive tract, which possesses the ganglia, lies along the under surface of the cord, and is nearest to the exterior of the body, just as the sensitive tract with its ganglia in man, lies nearest to the cutaneous or external surface. It will thus be seen, that the two tracts, maintain the same relative position with regard to each other, as well as to other parts of the body, in both divisions of the great kingdom of animated nature, whether the actual situation of the cord be along the dorsal or ventral surface of the body. This being the case, Mr. Newport, was led to consider the propriety of the terms *anterior* and *posterior tracts* or *columns*, as applied to the motor and sensitive tracts of the nervous system, and whether it would not be advisable entirely to abandon these terms, and designate the two columns *external* and *internal*, the sensitive the external, and the motor the internal column, since these terms would be strictly applicable to the situation or position of the columns in all classes of animals.

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*On the Nervous System of the Sphynx ligustri, Linn. and on the changes which it undergoes during a part of the Metamorphoses of the Insect, by George Newport, Esq. Communicated by P. M. Roget, M. D. Sec. Royal Society. Read June 7th, 1832. Phil. Trans. 1832, pp. 383, 398.

Part II, Phil. Trans. 1834, pp. 389, 423.

On the Nervous System of the Sphynx ligustri. Phil. Trans. 1834, p. 406.

On the Respiration of Insects. Phil. Trans. 1836, pp. 529, 566.

With regard to the cords themselves, it was long ago suggested by Weber, that the ganglia, which we now find to exist entirely in the sensitive tract in insects, are analogous to the invertebral ganglia of vertebrata. Hence the analogy between the spinal cord of the vertebrata, and the abdominal cords in invertebrata, is very nearly proved. The very great analogy, between the origin, course, and situation of the vagi nerves in man, and the corresponding nerves in insects, clearly demonstrates the identity of the structures.

Dr. Marshall Hall, in his first paper *on the Reflex Function of the Medulla Oblongata, and Medulla Spinalis*, which was read before the Royal Society of London, June 20th, 1833, and published in the Philosophical Transactions of 1833, (pp. 635, 665,) gave an account of a principle of action in the animal economy, which he conceived, had not before been distinguished with sufficient precision from the other vital and animal functions. The principle or function which he endeavored to establish and illustrate by vivisections and pathological and physiological facts, is connected in a peculiar manner with the medulla oblongata and the medulla spinalis, being excited by causes in a situation which is *eccentric* in the nervous system, that is distant from the nervous centres.

According to Dr Hall, whilst many of the phenomena of this principle of action, as they occur in the limbs had been observed, this function is by no means confined to the limbs, for, whilst it imparts to each muscle its appropriate tone, and to each system of muscles its appropriate equilibrium or balance, it performs the still more important office of presiding over the orifices and terminations of each of the internal canals in the animal economy, giving to them their due form and action; and, in the second place, in the instances in which the phenomena of this function have been noticed, they have been confounded with those of sensation and volition; or if they have been distinguished from these, they have been too indefinitely denominated, instinctive or automatic. This property is characterized by being *excited* in its action, and *reflex* in its course; in every instance in which it is exerted, an impression made upon the extremities of certain nerves, is conveyed to the medulla oblongata, or the medulla spinalis, and is reflected along other nerves to parts adjacent to, or remote from that which has received the impression. It is by this reflex character of the function, that Dr. Hall affirms that it is to be distinguished from every other.

Thus, according to Dr. Hall, there are in the animal economy, four modes of muscular contraction. The *first*, is that designated *voluntary* volition, originating in the cerebrum, and spontaneous in its acts, extends its influence along the spinal marrow and the motor nerves, in a *direct line*, to the voluntary muscles. The *second*, is that of the *respiration*; like volition, the motive influence in respiration passes in a *direct line* from one point of the nervous system to certain muscles; but as voluntary motion seems to originate in the cerebrum, so the respiratory motions originate in the medulla oblongata; like the voluntary motions, the motions of respiration are spontaneous; they continue at least, after the eighth pair of nerves has been divided. The *third* kind of muscular action in the animal economy is that termed *involuntary*; it depends upon the principle of irritability, and requires the *immediate* application of a stimulus to the nervo-muscular fibre itself. These three kinds of muscular motions, Dr. Hall regarded as being well known to physiologists, and he expressed the belief that they were all, which had been up to the time of his investigation, pointed out. There is however, according to Dr. Hall, a *fourth*, which subsists, in part after the voluntary and respiratory motions have ceased by the removal of the cerebrum and medulla oblongata, and which is attached to the medulla spinalis, ceasing itself when this is removed, and leaving the irritability undiminished. In this kind of muscular motion, the motive influence does not originate in any central part of the nervous system, but at a distance from the centre; it is neither spontaneous in its action, nor direct in its course; it is, on the contrary, excited by the application of appropriate stimuli, which are not, however, applied immediately to the muscular or nervo-muscular fibre, but to certain membranous parts, whence the impression is carried to the medulla, reflected, and reconducted to the part impressed, or conducted to a part remote from it, in which muscular contraction is effected. The first three modes of muscular action are known only by actual movements or muscular contractions; but the reflex function exists as a continuous muscular action, as a power presiding over organs not actually in a state of motion, preserving, in some, as the glottis, an open, in others, as the sphincters, a closed form, and in the limbs a due degree of equilibrium or balanced muscular action—a function, in the opinion of Dr. Hall, not previously recognised by physiologists.

The three kinds of muscular motion previously known may be distinguished in another way. The muscles of voluntary motion and of respiration may be excited by stimulating the nerves which supply them, in any part of their course, whether at their source, as a part of the medulla oblongata or medulla spinalis, or exterior to the spinal canal; the muscles of involuntary motion are chiefly excited by the actual contact of stimuli. In the case of the reflex function alone, the muscles are excited by a stimulus acting mediately and indirectly in a curved and reflex course, along superficial subcutaneous or sub-mucous nerves proceeding to the medulla, and muscular nerves proceeding from the medulla. The first three of these classes of muscular motion may act in detached limbs or muscles. The last requires the connexion with the medulla to be preserved entire. All the kinds of muscular motion may be [illegible]. But the reflex function is peculiar in being excitable into modes of action [illegible] in the animal economy, as in the cases of sneezing, coughing, vomiting, etc. The reflex function [illegible] permanently diminished or augmented [illegible] Marshall Hall therefore treated of the reflex function [illegible] the muscular system, as excitable into various [illegible] and as assuming [illegible] forms.

[illegible]

irritability entire; it is not excited immediately like the movements of irritability, but mediately in a reflex course, through the medulla, from the part stimulated to the part moved.

In a state of health, the reflex function presides over the orifices and terminations of the internal canals, such as the glottis and the sphincters, preserving the former open, the latter closed; and it maintains the due tone of each muscle, and the due equilibrium of each system of muscles; when excited, it gives origin to the movements observed in deglutition or vomiting, sneezing, tenesmus, etc., when morbidly augmented, it constitutes certain forms of disease, as tetanus, hydrophobia, certain forms of tremor, paralysis agitans, chorea, stammering, etc.; when diminished, it induces those forms of tremor observed when the vital powers are enfeebled; when otherwise morbid, it occasions other forms of disease, as the convulsion, the croup-like respiration, the affection of the sphincters, observed in dentition the various effects of intestinal irritation, etc. The effects of the excited reflex function are sometimes observed in a part near that irritated, as in the eyelids in winking, in the glottis in inhaling a drop of water or particle of food, in the sphincters ani in dysentery, etc.; sometimes in parts *remote*, as in the irritation of bathing, when this induces strabismus, convulsion, the croup-like respiration, relaxed sphincters, etc. All the functions of the muscular system which remain after the sources of the motive influence of the voluntary and respiratory motions are removed, with the exception of those of the heart, and other muscles which contract upon the principle of excited irritability, depend upon the reflex function.

Dr. Hall thus enumerates the principles of the movements in the animal economy, viewed in an anatomical and functional point of light.

1. The cerebrum, or the source of the voluntary motions.
2. The medulla oblongata, or the source of the respiratory motions.
3. The medulla spinalis generally, the middle arc of the reflex function.
4. The nervo-muscular fibre, or the seat of the irritability.
5. The sympathetic, or the source of nutrition, of the secretions. etc.

The reflex function of the different portions of the medulla presides over their corresponding organs; the medulla oblongata presides over the larynx and the pharynx; the lumbar and sacral portion of the medulla spinalis presides over the sphincter ani, the cervix vesicae; and intervening portions of the medulla give tone and equilibrium to the corresponding portions of the muscular system, and what LeGallois has designated "*life*" to the corresponding regions of the body. But the operation of the reflex function, is by no means, confined to parts corresponding to distinct portions of the medulla. The irritation of a given part may, on the contrary, induce contraction in a part very remote; the irritation of bathing may induce spasmodic action or relaxation of the sphincters.

Dr. Marshall Hall made the following applications of his views, to the explanation of certain pathological phenomena; affirming that the study of the reflex function revealed and explained a totally new order of facts in pathology, and lead to a new division of diseases of the nervous system, coinciding with the different modes of operation of their causes, into those of *centric* and those of *eccentric* origin:

> "One of the most interesting medical subjects, in relation to the reflex function, is that of dentition. Dentition is a sort of natural experiment upon this function. The general convulsion, the strabismus, the spasm of the fingers and toes, the croup-like affection of the respiration, the repeated vomitings, the tenesmus, the strangury, the involuntary discharge of urine and of the fæces, from its operation, denote the influence of irritation of the maxillary nerves, through the medium of the medulla oblongata, upon the muscles of voluntary and respiratory motion of the eye, the larynx, the sphincters, etc., in the human subject, and indicate so many arcs of the reflex functions. * *
>
> "With the effects of dentition in infants, some affections of the adult may be compared as chorea, some forms of epilepsy, and some forms of asthma. The diseases to which these designations have been given, vary exceedingly in different instances; inasmuch as some cases are of centric and others of eccentric origin. * *
>
> "Epilepsy is plainly of two kinds: the first has a centric origin in the medulla itself; the second is an affection of the reflex function, the exciting cause being eccentric, and acting chiefly upon the nerves of the stomach or intestines, which consequently form the first part of the reflex arc. * *
>
> "True asthma, viz: that form of this disease which occurs in youth, and assumes a distinctly spasmodic form and course, like so many other morbid conditions of the reflex function, frequently arises from gastric or intestinal irritation. * *
>
> "With the effects of dentition, those of gastric or enteric irritation, in their multiplied forms may be compared.
>
> "Tenesmus and strangury are affections of other arcs of the reflex functions. * *
>
> "Tetanus and hydrophobia appear equally to result from injuries inflicted upon the extremities of certain nerves, by means of which the morbid influence is conveyed to the medulla, whence it is reflected through the motor nerves to the muscular system. As free lancing of the gums in dentition, so the early division of the wounded nerve or amputation in tetanus, has at once checked the morbid affection. * *
>
> "Certain poisons as strychnine, induce excess in the reflex function; other poisons as the hydrocyanic acid, destroy it altogether. In both cases the muscular irritability remains perfect and undiminished. It is probably through the medium of the same functions, that many other poisons act upon the animal economy." * *

It is evident from the preceding analysis of the first paper of Dr. Marshall Hall, on the *Reflex function* of the nervous system, that Professor Trousseau is to a certain extent in error, when he claims for Professor Graves the honor of having anticipated by many years the discoveries of Dr. Hall.

In Professor Trousseau's criticism on the "*Clinical Lectures on the Practice of Medicine by the late Robert James Graves, M. D. F. R. S.*," *etc.*, he makes the following statement:

> "On the other hand, I cannot sufficiently commend the perusal of the lectures, which treat of paralyses; they contain a complete doctrine, and this doctrine has decisively triumphed. The sympathetic paralyses of Whytt and Prochaska, have now their place assigned in science, under the much more physiological name of reflex paralyses, and the Dublin professor is the first who has studied with exactness their etiological conditions, as he is the first who has made known their pathogenic process. Anticipating by many years the admirable works of Marshall Hall, he has comprehended, he has seen that anomalous peripheric impressions may react upon any section of the medulla, and determine at a distance disturbance of movement or of sensibility; he has in a word, created the class of phericor reflex paralyses, and has clearly established the relations existing between these paralyses and acute diseases."
>
> "Unhappily, these remarkable lectures have remained a sealed letter for the majority of French practitioners; but it is time to render to the physicians of the Meath Hospital the justice which is due to them; it ought to be known that Graves is the creator of this new doctrine, which has profoundly modified within a few years, the pathology of the nervous system; it is right, in fine, to refer to its true author the suggestive theory of the paralysis and the convulsions of peripheric origin."

The claim thus advanced by Professor Trousseau, in behalf of Professor Graves, is wholly untenable, as the first edition of the *Clinical Lectures* of the latter, was published in 1843, ten yeays after the publication by the Royal Society of Dr. Hall's paper.

The views expressed in the first paper of Dr. Marshall Hall, were finally expanded into his elaborate work *On the Diseases and Derangements of the Nervous System*, published in 1841. The following is a brief analysis of the matured views of this distinguished observer and physiologist, as contained in the work just mentioned.

According to Dr. Marshall Hall, the nervous system must be divided into

I. The Cerebral, or that of Sensation and Volition

II. The True Spinal, or that of the Movements of Ingestion and Egestion; and

III. The Ganglionic, or that of the Movements of the Internal Muscular Organs, of Nutrition, Secretion, etc.

TABLE OF THE NERVOUS SYSTEM.

I. *The entire Nervous System is divisible into*
    I. The Cerebral.
    II. The True-Spinal.
    III. The Ganglionic.
II. *The Cerebral System is*
    I. The seat of the Soul, and
    II. The system of
        1. Sensation and of the Senses.
        2. Volition and of Spontaneous Motion.
        3. Sleep and Fatigue.
III. *The True Spinal System.*
    I. The principle of Action is the Vis-Nervosa.
    II. Its Modes of Action are excited, and reflex or direct.
} Mixed Functions.
    III. The Reflex Functions are those of
        1. Ingestion and Retention.
        2. Egestion and Exclusion.
    IV. The Direct Functions are
        1. The Tone } of the Muscular Fibre.
        2. The Irritability } of the Muscular Fibre.
IV. *The Ganglionic System.*
    I. The Principle of Action is the Vis-Nervosa.
    II. The Mode of Action excited, direct or immediate.
    III. The Functions those of
        1. The Internal Muscular Organs.
            1. The Heart and Arteries.
            2. The Stomach and Intestines.
} Mixed in the Œsophagus: the Rectum.
        2. Nutrition.
        3. Secretion, etc.
V. *The System of Emotions, these are*
    I. Psychical Affections, acting through
    II. The True Spinal, and
    III. The Ganglionic Systems.

The *cerebral* system, comprises every part of the nervous system, which relates to *sensation* and *volition*, the nerves of the *senses*—the olfactory, the optic, the auditory, the gustatory, the nerves of touch, and the whole of the nerves of voluntary motion. Its centre is the cerebrum, including the cerebellum; its sentient nerves run variously from the organs of sense, and from the external surfaces, first without the cranium or spine, and then within the cranium or spine to that centre; its voluntary nerve pursue a similar but retrograde course *from* that centre to the muscles of voluntary motion. * *

The cerebro-spinal subdivision of the nervous system, or as it would be more correctly designated, the cerebral, is the system of *sensation* and volition. It is the system by which we are connected *intellectually* with the external world. It is that by means of which we feel and perceive external objects, and by which we approach them and appropriate them to our use entirely. My fingers being in contact with any object of moderate size, I feel, I perceive it, and by an act of volition, I raise it from the table. This apparently simple operation, requires *three* portions of anatomy:

1. Certain nerves must proceed continuously, uninterruptedly, *from* the points of my fingers to the cerebrum, the centre of this system;
2. The cerebrum must be in a state of integrity:
3. Certain nerves must proceed from the cerebrum to the muscles which are to be called into action.

There are, then, *two sets* of cerebral nerves; at least there are cerebral nerves having two *functions*.

From the experiments of Sir Charles Bell, sustained and extended by those of Professor Müller, we may conclude that

1. The Aganglionic nerves are the voluntary or motor nerves.
2. That the ganglia or general columns are the centres of the incident and reflex nerves, and of the reflex actions.

It remains to be ascertained whether the *sentient* nerves belong to the *ganglionic* columns; but this seems most probable.

The *cerebral, or sentient or voluntary* division of the nervous system, comprehends,

I. Sentient nerves, leading to the posterior roots of the trifacial and spinal nerves, and the posterior columns of the spinal marrow.

II. The cerebrum, the centre of the system.

III. The voluntary nerves issuing from the anterior columns of the spinal marrow and the anterior roots of the trifacial and spinal nerves.

The *physiology of the cerebral system*, comprises sensation in all its forms, perception, judgment, volition, and voluntary motion.

The senses are the smell, the sight, the hearing, the taste, the touch; they convey to the mind all that we know of the external world. Perception is derived from these. Judgment is a purely mental act. So is volition; and of this voluntary motion is a frequent result. The motions which result from sensation generally *imply volition;* but as volition may exist without any previous sensation, the voluntary motions frequently are, and *may be* at any time *spontaneous.*

Sensation or some effect of the impression which produces it, must be conveyed by an appropriate nerve uninterrupted to the cerebrum,—to the soul; and thence the act of volition must act through a voluntary nerve, equally uninterrupted in its course, from the cerebrum to the muscle or muscles to be moved. Thus we have a nervous arch, of which the cerebrum is the keystone.

Many attempts have been made to *localize* the function of the cerebrum; that is, to prove certain functions to be attached to certain parts of that organ; without, however, much success. The facts supplied by pathology certainly lead us to the conclusion that the hemispheres of the cerebrum and cerebellum regulate the *voluntary* movements of the opposite side of the body; whilst the medulla oblongata and spinalis *convey* the influence of stimuli to the corresponding side. It has been asserted, from similar facts, that the anterior lobes of the brain govern speech; the corpora striata, the inferior extremities; and the thalami, the superior extremities; but these deductions are not sufficiently substantiated. The same remark must be made relative to the supposed connection between the cortical portion of the cerebrum and the intellectual faculties, and the cineritious portions and the movements.

Pathology of the Cerebral System. The cerebral system being the system of the sensations, of judgment, of volition, it is to it that we must refer all morbid conditions of these mental acts or functions. Every derangement of the senses, every form of dilerium or of coma, or of perverted imagination or judgment, every act of violence must be referred to the condition, primary or secondary, of the cerebrum or cerebellum.

THE TRUE SPINAL OR EXCITO-MOTORY SYSTEM.

This system, formerly confounded with the cerebral, under the designation of cerebro-spinal—this system as a system, Dr. Hall considers as having been entirely elicited by his own laborious and persevering researches.

Its anatomy involves a system of incident, and reflex nerves connected with the true-spinal marrow as their centre; unknown, in this special connection before;

Its physiology consists in functions, all of which are performed through this peculiar anatomy. These functions comprise all the acts of injestion, of retention, of expulsion, and of exclusion, in the animal economy; they are those, therefore, on which depend

I. *The Preservation of the individual, and*

II. *The Continuance of the Species.*

All these functions are reflex-spinal functions of which the idea did not formerly exist; its principle of action is the vis-nervosa of Haller, a motor power, of which, there was previously no application to physiology whatever; its pathology comprises the whole class of spasmodic diseases, and its sub-division into those of

1. Incident.
2. Centric.
3. Reflex Origin.

TABLE OF THE ANATOMY OF THE TRUE-SPINAL SYSTEM.

I. The Incident Motor Branches.
  1. The Trifacial arising from—
    1. The Eye-lashes.
    2. The Alæ Nasi.
    3. The Nostril.
    4. The Fauces.
    5. The Face.
  2. The Pneumogastric from
    1. The Pharynx.
    2. The Larynx.
    3. The Bronchia.
    4. The Cardia,—Kidney, and Liver.
  3. The Glosso Pharyngeal?
  4. The Posterior Spinal, arising from—
    1. The General Surface.
    2. The Glans Penis and Clitoridis.
    3. The Anus.
    4. The Cervix Vesicæ.
    5. The Cervix Uteri

II. The True Medulla Oblongata and Medulla Spinalis, the Centre of the System.

III. The Reflex, Motor Branches.
  1. The Trochlearis } Oculi.
  2. The Abducens. } Oculi.
  3. The Minor portion of the Fifth.
  4. The Facial, distributed to
    1. The Orbicularis.
    2. The Levator Alæ Nasi.
  5. The Pneumogastric or its Accessory.
    1. The Pharyngeal.
    2. The Œsophageal and Cardiac.
    3. The Laryngeal.
    4. The Bronchial, etc.
  6. The Myo-glossal.
  7. The Spinal Accessory.
  8. The Spinal, distributed to the
    1. Diaphragm, and to
    2. The Intercostal and } Muscles.
    3. The Abdominal } Muscles.
  9. The Sacral, distributed to
    1. The Sphincters.
    2. The Expulsors, the Ejaculators, the Fallopian Tubes, the Uterus, etc.

All the nerves represented on the left side of this table are *incident motor nerves.* Some of them are *sentient;* but whether sentient or not they are demonstrably *excito-motor*, and whilst they are motor, they are incident. Respiration has its primium mobile in *incident excito-motory nerves.* By the cerebral system, we are placed in relation to the external world *psychically* or *mentally;* but by the true spinal system we are placed in a similar relation *physically*. As by the former we imbibe all our ideas, so by the latter we appropriate external objects to our very substance. On the true spinal system all ingestion, all retention, all expulsion, in regard to the animal frame and economy depend. Every such act is a *spinal* act, a true spinal act, reflex in its form and character, accomplished through the medium of the incident and reflex nerves, and their connecting centre the true spinal marrow, and by the *agency* of the *vis-nervosa.*

TABLE OF THE PHYSIOLOGY OF THE TRUE SPINAL SYSTEM.

I. *The Excited Action—*
- 1. Of the Eyes, the Eye-lids; (and of the Iris?)
- 2. Of the Orifices. { 1. The Larynx. 2. The Pharynx.
- 3. Of the Ingestion.
  - 1. Of the food.
    - 1. In Suction;
    - 2. In Deglutition.
  - 2. Of the Air, or Respiration.
  - 3. Of the Semen, or Conception.
- 4. Of Exclusion.
- 5. Of the Expulsors, or of Egestion.
  - 1. Of the Fæces;
  - 2. Of the Urine;
  - 3. Of the Perspiration;
  - 4. Of the Semen;
  - 5. Of the Fœtus, or Parturition.
- 6. Of the Sphincters.
  - 1. The Cardia.
  - 2. The Valvula Coli?
  - 3. The Sphincter Ani.
  - 4. The Sphincter Vesicæ.

II. *The Direct Action or Influence—*
- I. In the Tone, } of the Muscular System.
- II. In the Irritability, } of the Muscular System.

The true spinal marrow may be correctly viewed as a distinct *organ*, totally different in its properties and functions from the cerebrum, and as the centre of a distinct system of nerves, different from the sentient and voluntary, and possessed of a peculiar and special motor power, which acts in incident as well as reflex directions for special purposes—judging entirely from experiment. It may be received as a principle that every part of the nervous system, which is endowed with the excito-motory power, belongs to this system, whether this power be excited in the direction of the nerves *from* or *towards* the nervous centres. * * Each nerve of the excito-motory system, with the exception perhaps, of the pneumogastric, is a compound nerve, having a cerebral, as well as a true spinal origin. * * The most usual effect produced by stimulating incident nerves, is a motion of the limbs. But in other instances we have acts of inspiration, of deglutition, of expulsion, of closure in the eye-lids, larnyx, pharnyx, and the sphincters:—interesting facts, which speak a physiological language, and assign distinct and special offices to certain excitor-nerves.

THE PATHOLOGY OF THE TRUE SPINAL SYSTEM.

The abnormal and morbid actions of the *vis-nervosa* or *excito-motory* power, obey the same laws as in health.

The morbid stimulus may act upon the incident, the central, the reflex part of the excito-motory arc or arcs, and produce corresponding effects—corresponding diseases. To use words familiar to the physiologists of Germany, we have a class of centripetal, central and centrifugal diseases. We may have centripetal or central epilepsy, and we may have spasmodic tic, and other affections, from an affection of the reflex motor nerves.

In this manner, *the class of spasmodic diseases* is sub-divided into *three* sub-classes, a division of the utmost importance in practice, and illusrated in the following table.

TABLE OF THE PATHOLOGY OF THE TRUE SPINAL SYSTEM.

I. Diseases of the Incident Nerves.

I. 1. Dental. 2. Gastric. 3. Intestinal.	Irritation in Infants.	1. The Crowing Inspiration. 2. Strabismus, Spasm of the Fingers and Toes; Strangury; Tenesmus; etc. 3. Convulsion. 4. Paralysis?
II. 1. Gastric. 2. Intestinal. 3. Uterine.	Irritation in Adults.	I. Hysteria. II. Asthma. III. Vomiting; Hiccup; etc. IV. Epilepsy. V. Puerperal Convulsion; etc.

III. Traumatic Tetanus; Hydrophobia; etc.

II. Diseases of the Spinal Marrow itself.
- I. Inflammation and other Diseases.
- II. Diseases of the Vertebræ and Membranes.
- III. Counter-pressure, etc., in Diseases within the Cranium.
- IV. Centric Epilepsy, Tetanus, etc.
- V. Convulsions from Loss of Blood; etc.

III. Diseases of the Reflex or Motor Nerves.
- I. Spasm.
  - 1. Spasmodic Tic.
  - 2. Torticollis.
  - 3. Contracted Limbs; etc.
- II. Paralysis.

PARALLEL OF THE PHYSIOLOGY AND SYMPTOMS.

	HYSTERIA.	CROWING INSPIRATION.	EPILEPSY.	TETANUS.	HYDROPHOBIA.
THE EXCITABILITY.				Undue excitability.	Excitability extreme.
I. THE EYE THE FACE, ETC.		Strabismus.	Strabismus; contortion of the face; bitten tongue or lip; etc.		
II. THE PHARYNX.	Dysphagia.			Dysphagia; pharyngeal spasm.	Suffocative dysphagia pharyngeal and laryngeal spasm; etc.
III. THE LARNXY.	Globus; aphonia; larynx open.	1. Partial closure, with crowing inspiration.	Partial loss of voice.		
IV. THE RESPIRATION.	1. Urgent thoracic dyspnoea. 2. Respiration solely diaphragmatic. 3. Vomiting; hiccup; etc.	2. Total closure, with expiratory efforts.	Closure with expiratory efforts.	Dyspnoea; pain at the ensiform cartilage.	
V. THE EXPULSORS; SPHINCTERS.	Constipation. 1. Dysury. 2. Retention of urine.	1. Tenesmus. 2. Dysury.	Discharge of 1. Fæces; 2. Urine; or 3. Semen.	Constipation; contracted sphincter ani?	
VI. THE MUSCULAR SYSTEM.	Convulsion; trismus; tetanus; contracted hands, feet, etc.	1. Contracted {thumb, fingers, and toes, 2. Convulsion.	Convulsion.	Trismus; emprosthotonos; opisthotonos; etc.	

TABLE OF THE ACT OF VOMITING.

I. The Excitors and Motors which close the Larynx.
II. The Excitors and Motors which open the Cardia.
III.

I. The Excitors,	II. The Centric Organ of Expiratory Effort.	III. The Motors.
1. The Facial branch of the Trifacial. 2. The Gastric, Renal, and Hepatic branches of the Pneumogastric. 3. The Intestinal or Uterine branches of the Spinal nerves.	The Medulla oblongata.	The Spinal nerves distributed 1. To the intercostal and 2. To the abdominal muscles.

Dr. Marshall Hall thus concludes his observations on the nervous system in general. This system is divisible into

I. The cerebral, or physical, or that of our relation to the external world *mentally*.

II. The true-spinal, or excito-motory, or that of the reflex action of the *vis-nervosa*, or of our appropriation of certain *objects of* the external world *physically* and in *masses*; and

III. The ganglionic, or the system of *interstitial*, or *chemical*, or *atomic* changes of nutrition, secretion, etc., also under the immediate influence of the *vis-nervosa*.

IV. Intermediate between the *first* and *second* of these is the influence of *emotion*, *passion*, *etc*.

V. Intermediate between the *second* and *third* are the internal muscular organs, the heart, the stomach and intestines, etc.; and these are under the *immediate* influence of the *vis-nervosa* and the *irritability* of the muscular fibre.

VI. Lastly, the *tone* and *irritability* of the general muscular system are *constant*, and *direct effects* of the true-spinal and ganglionic systems, and of the *vis-nervosa*. *On the diseases and derangements of the nervous system, in their primary forms and in their modifications, by age, sex, constitution, hereditary pre-disposition, excesses, general disorders and organic disease*. by Marshall Hall, M. D., etc. London, 1841, p. 1 to 130.

It would be foreign to the object of this Historical Outline to extend the preceding analysis to the application by Dr. Hall of his views to the various diseases of the nervous system and their modifications by age, sex, constitution and hereditary pre-disposition, with which this physiologist and physician concludes his elaborate work.

With reference to the use of the term reflex, by Dr. Hall, it has been observed by certain critics upon his labors, that the same expression occurs in the works of Haller, Unzer, Próchaska, Fred. Arnold, Treviranus and others. I have already endeavored to do full justice to the labors of Unzer, Prochaska, sir Charles Bell and others, quoting the passages of greatest interest or of greatest concern with reference to the grand doctrines relating to the structure and functions of the nervous system. Fred. Arnold, in his work entitled *Kopf-theil des vegetativen Nervensystems*, published in 1830, makes frequent use of the term reflexion: thus his experiments induced him to admit, that the action of light, does not take place immediately upon the retina, but that it is *reflected* through the nervous expansion in the eye to the iris, and that this *bringing back* of the stimulus of light takes place through the brain. He also distinguishes the motions of the tympanum which arise in consequence of an irritation *reflected* from the auditory nerve to the moving apparatus of this nerve, from those which immediately follow through the vibrations of the air. The sympathy of the thoracic and abdominal organs with the brain and organs of sense, he also accounts for on the principle of reflexion. We fail to perceive in the views of Arnold any advance on the observations of Prochaska, who alludes to a *reflex action*, as seen in the act of sneezing, coughing, etc., and dwells at length upon the influence of the nervous system upon the circulation of the blood: whilst they are far less explicit than the views of Sir Charles Bell on the nervous circle which connects the voluntary muscles with the brain, published in the Philosophical Transactions of 1826, a careful analysis of which we have already presented.*

The effort has been made also to show, that the facts, on which the reflex theory is founded, possess still less of novelty than the theory itself.

Thus it was long known that the life of certain animals may continue for some time without a cerebrum and cerebellum, and that amphibious animals, after taking off their heads, are still capable of making suitable movements: they seek to avoid injuries, and fly from dangers. We have already quoted Unzer and other physiologists who have recorded such facts. Robert Whytt, who was born 1714 and died in 1766, and held the chair of medicine in the University of Edinburgh, recorded the fact, that: if immediately after decapitating a frog, one of the toes of the hind-foot be wounded either very slight motion or none at all takes place in the muscles of the foot. But if we pinch or wound this animal's toe, ten or fifteen minutes after the head has been cut off, then, not only the muscles of the leg and thigh, but those of the entire body, are thrown into strong convulsions, and the frog sometimes springs up violently. "In this case is not the irritation of the thigh, immediately after the head is cut off, ineffectual in producing any motion in the muscles of the thigh and foot, on account of the great pain occasioned by removing the head? Whereas the muscles are thrown into motion by wounding the toe fifteen minutes after removing the head, because the pain is now so much diminished, that it no longer prevents the animal from being sensible of the pain of his wounded toe."

Gilbert Blane, has quoted some facts, which show that instinctive actions, even in animals possessing a brain and nerves, do not depend on sensation: that is, that instinctive or automatic acts may be performed without the intervention of the sensorium commune, and therefore without sensation or consciousness. Treviranus was induced by experiments such as these, to deny the assumption that the faculty of association is merely a property of the brain. Le Gallois, states it as a well known and proved fact, that birds, whose heads were cut off, continued to live and even to run about for some time after: Mayo also ascertained the fact that decapitated animals are capable of performing determinate and suitable acts under the influence of irritants.

Le Gallois in his memoir published in 1812, also states that in the rabbit, after division of the cord in the lumbar region, sensation and voluntary motion continued to take place, even in the posterior extremities. But there is no longer any connection in sensation or movements between the anterior parts posterior to the section of the cord; that is to say that, if the tail, or, indeed, one of the hind-feet be pinched, the entire posterior parts are agitated, but the anterior parts seem to feel nothing and do not move. (Expèriences sur le principe de la vie.)

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* Professor Bellingeri's doctrine of nervous antagonism, advanced in his "*Osservazioni Pathologiche*," bears some resemblance to Dr. Marshall Hall's reflex function.

Fodéra, in 1822, stated, that, in wounds of the spinal cord, the animal suffers pain and convulsions; if it be divided transversely, there is paralysis of the posterior parts, with loss of sensation and motion. But irritation applied below the section produces agitation of the muscles to which the nerves derived from it are distributed. The animal does not suffer pain, for it has no consciousness of what takes place in these parts. With regard to the spinal cord, complete transverse section in birds does not in general entirely paralyze the posterior extremities; if we pinch the foot they withdraw it, although they suffer no pain from it, but if the spinal cord be entirely destroyed in the interior of the vertebral canal, the paralysis is perfect. (Recherches, expérimentales, sur le système nerveux.) About the same time Mayo, thus described the reflex function of the spinal cord.

> "On the one hand it is clear that an influence independent of the will, occasionally throws voluntary muscles into action, as appears in tetanus and other spasmodic diseases; and is shown remarkably in the physiological experiment of irritating the skin on the lower extremities, after the division of the spinal cord in the back, when the occurrence of action limited to the muscles of the inferior extremities evinces that a connection exists independently of the will, between sentient surfaces and the action of voluntary muscles. I have varied this experiment by dividing the spinal cord at once in the neck and in the back, upon which three unconnected nervous centres exist; and the division of the skin of either part (and especially at the soles of the feet, in the two hinder portions) produces a convulsive action of the muscles of that part alone. The same influence may, then, possibly regulate the unconscious actions to which these remarks relate." Anat. and Phys. Comm., No. 11, 1823.

It has therefore with some reason, been affirmed, that the facts by which Marshall Hall supports his theory, were well known long before his time, and were employed to throw light upon the functions of the nervous system.

It must be admitted however that great obscurity and confusion prevailed in the statements of most of the writers before his investigations, and the idea of an *incident motor* nerve did not exist; and consequently, the system of such nerves, and the special physiology of this system was totally unknown, and it must still farther be admitted that Dr. Hall has the merit of having introduced a valuable anatomical, physiological and pathological classification, of the parts and functions of the nervous system, based upon actual observation and experiment, logically connected and to a great extent adapted to the wants of the physiologist, pathologist and practitioner of medicine and surgery. The labors of Dr. Hall have thrown a flood of light upon many nervous diseases, and have tended to introduce order and harmony into this difficult department of medical science.

Decided proofs that the reflex movements are independent of sensation have been afforded by certain phenomena of nervous diseases: thus in cases of paraplegia dependent on lesion of the dorsal or cervical portion of the spinal cord, its lumbar portion remaining healthy, slight irritation of the surface of the lower extremities as by tickling the sole of the foot, the passage of a catheter, or the evacuation of the fæces, will produce convulsive movements of the feet and legs, even though they be perfectly devoid of voluntary power and sensation. The first cases[*] of this kind adduced in illustration of the theory of reflex movement, were observed by Mr. Barlow, Dr. Budd, and Mr. Barron. The same phenomena occur in cases of hemiplegia; an instance of which has been recorded by Dr. William Baly.[†] Dr. Reid remarks, that the sensations which attend some of the reflex motions have been added for an ulterior object—that it is necessary both for comfort and well-being, that these movements (such as those by which the contents of the bladder and rectum are expelled,) should be influenced by volition, and that this of course, could only be accomplished by associating sensation with the excitation of the impression.

Among the Germans the eminent physiologist J. Müller was the first who advocated the reflex theory of Marshall Hall, and by some writers the discovery of the mechanism of reflex action, has been given to both these physiologists; but aside from the fact that the labors of the former were published one year after those of the latter had been presented to the Zoological Society, it is evident from a careful examination of the works of Müller, that he makes no special claim to priority in this discovery, although conducting his researches independently of, and differing on certain points from Dr. Hall.

The views of Professor J. Müller, may be thus stated, as finally matured and presented in the second edition of his great work on physiology,[‡] and after he had (as is evident from his statement) carefully examined the works of Dr. Hall.

When impressions made by the action of external stimuli on sensitive nerves give rise to motions in other parts, these are never the result of the direct reaction of the sensitive and motor fibres of the nerves

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[*] Hall's Memoirs, p. 63, Mr. Granger's Observations on the Spinal Cord, p. 93, Dr. W. Budd, Med. Chir., Trans. vol. xxii.

[†] Elements of Physiology by J. Müller. M. D. 1st Ed. Trans. by William Baly, M. D., Vol. I, p. 721.

[‡] Elements of Physiology, 2d Ed., London 1840, Vol 1, pp. 754, 778.

on each other; the irritation is conveyed by the sensitive fibres to the brain and spinal cord, and is by them communicated to the motor fibres. The experiments detailed by Professor Müller, in support of this proposition, render it evident that the general spasms excited in animals by touching points of the surface, do not depend on a communication between the sensitive and motor fibres in the nerves, but upon the fact, that the spinal cord is the essential link between the centripetal impression conveyed by the sensitive fibres, and the centrifugal influence of the motor nerves. The facts established experimentally by Müller, prove likewise, that the phenomena of general spasms, thus excited, are not dependent on the sympathetic nerves, but that they are owing to an irritation of the spinal cord, by virtue of which every impression conveyed to it by the sensitive fibres, even though quite local, is propagated through the whole spinal cord and brain, and thus necessarily excites all the motor fibres given off from them. The state of irritation of the spinal cord, here referred to, may be produced by the following causes: by the mere division and contusion of the spinal cord; by the action of certain poisons, as nux-vomica; by such causes as produce exhaustion of the brain and spinal marrow, by excessively exciting them; severe local irritation of a sensitive nerve may, by the intensity of the impression conveyed to the brain and spinal marrow, give rise to twitchings of the muscles and tremors, as in severe local burns, extraction of a tooth, &c.; local irritation of the nerves, from inflammation or ganglionic enlargements, frequently give rise to general spasms and even to epilepsy; irritation of the spinal cord, arising from local excitement communicated by sensitive fibres, as in traumatic tetanus; great irritation of the sympathetic nerves in the intestinal canal, as in cholera and the intestinal affections of children. Such facts merely lead to the admission of the law, that whenever general spasms are excited by local impressions, the phenomena depend on no other communication between the sensitive and motor fibres, than what exists in the spinal cord. In very many cases, however, local irritation of the nerves gives rise, not to general, but to local muscular spasms; in this case again, according to Müller, the spinal cord is to be regarded as the band of communication between the sensitive and motor fibres. The cases of this kind are: local spasms, or spasms only of those muscles, the motor fibres of which arise from the same part of the spinal cord as the sensitive fibres that are irritated; as in the case of burns, the contraction of the iris under the influence of light, the winking of the eyelids under the long continued influence of light, the contractions of all the perineal muscles in the expulsion of the semen, which are excited by irritation of the sensitive nerves of the penis, the spinal cord being the medium of communication, between the sensorial impressions and the movements, the contraction of the glottis and air passages excited by the contact of irrespirable gases, the movements of deglutition, and the contractions of the sphincter ani and sphincter vesicæ; in spasmodic movements of the organs of respiration, as sneezing, coughing, hiccough, vomiting, &c., in contraction of the diaphragm and abdominal muscles, induced by irritation in the intestines or urinary organs, and in the expulsion of the fœtus in some cases after the death of the mother, we have examples that when the excitement of the sensitive nerve is entirely local, the reflected influence from the brain, may be more extended.

In the second kind of cases, the reflex action affects a large group of nerves—the respiratory nerves, and is excited most frequently by irritation of a mucous membrane. When this irritation, however is more intense, the irritation of the spinal cord becomes extensive, and is reflected upon almost all the nerves of the trunk.

The preceding is the view of J. Müller as given in the first edition of his work, published in 1833 and 1834, and it would appear that this theory was elaborated without any knowledge of the labors of Marshall Hall.

Professor Müller agrees with Dr. Hall, as to the reflected motions which occur after the loss of the brain, being no proof that stimuli applied to the skin are still able to excite true sensations in the spinal cord; the ordinary centripetal action of the nervous principle takes place in these cases just as when sensations are produced, but here it does not give rise to sensation, since it is not communicated to the brain, the organ of consciousness. During life, also, and in the state of health, many reflected motions are excited by impressions, which are not, as true sensations, communicated to the sensorium, but nevertheless exert a strong influence upon the spinal cord; as for example, in the case of the irritation of the fæces or urine, exciting the contractions of the sphincters. But Professor Müller held that Dr. Hall goes too far in admitting that, in the healthy state, every motion which follows true sensation is voluntary, and that all irritations of sensitive parts which give rise to reflected motions are unattended with sensation; for the reflected motions of sneezing, coughing, and many others, are consequent on true sensations. The reflected motions, and the involuntary not reflected motions, must not be confounded with each other. If the glottis of an animal be touched, says Dr. Hall, it contracts; so likewise does the heart when touched. The removal of the brain does not affect these phenomena; but if the medulla oblongata be taken away, the larynx can no longer be made to contract, while the action of the heart continues even after the removal of the spinal cord. The heart is affected immediately on the application of any stimulus, by virtue of its irritability; the impression made by a stimulus applied to the larynx, on the contrary, must be propagated to the medulla oblongata, and the contraction is effected indirectly through the medium of the latter part.

It results from the foregoing observations that spasmodic affections of the muscles occurring in diseased states, may have very different sources. There are spasmodic affections of which the cause is seated in the motor nerves themselves, or in the brain and spinal cord; but convulsions may also arise from the reflex action of the nervous system, their cause being irritation of the sensitive nerves. Of the muscular spasms of the latter kind we have instances frequently occurring, in consequence of intestinal irritation, in dentition, odontalgia, and from painful affections of the nerves generally, whether these be dependent on organic lesions or not.

All the phenomena hitherto described, agree according to Müller in the circumstances of the spinal cord being the medium of communication between the centripetal nervous action produced by the exciting stimulus, and the subsequent motor action of the nerves; but the different "paths" of communication in the spinal cord may be more distinctly defined. The most common form of reflected motion is that, when violent impression on sensitive nerves excites muscular contractions in the same limb; this is observed when the skin is burned, and in the first stage of narcotization of an animal, a stimulus applied to the skin excites contractions most rapidly in the irritated parts; thus also the stimulus of the food in the fauces, excites the act of deglutition; dust on the conjunctiva, closure of the eyelids; and irritation of the urine and fæces, the contraction of the sphincters. Hence, irritation propagated to the spinal cord must readily affect those motor nerves which arise nearest to the roots of the exciting sensitive nerves; in other words, that it is most prone to pass from the posterior roots, or the individual fibres of these roots, to the anterior roots of the same nerve, like electricity, leaping by the most direct course, from one pole to the other. When the motor influence of the spinal cord is strongly excited by a sensitive nerve, that part only is affected which is nearest to the root of the nerve; and the irritation of the cord, and of the motor nerves arising from it, diminishes in proportion with the distance from that point. In the same way, in the brain the irritation is communicated from certain sensitive to certain motor nerves. Thus the optic and acoustic nerves, and the sensitive branches of the fifth nerve, are prone to excite reflex actions of the ciliary branches of the third pair and of the facial nerve. The sensitive and motor nerves which thus react on each other through the medium of the brain and spinal cord, seem to stand in such a mutual relation, that a change in the condition of one produces a change in the other; just as the scale of a balance rising causes the other to descend, or as the sinking of the fluid in one branch of a bent tube makes it rise in the other. The form of reflex action next in frequency to that just described, is the production of spasmodic contractions of the respiratory muscles from the irritation of the mucous membranes. Hence, there must pre-exist in the medulla oblongata and spinal cord some means of ready communication between the sensitive nerves of the mucous membrane, (the fifth nerve of the nostrils; the vagus nerve in the trachea, lungs, pharynx, œsophagus and stomach; the sympathetic nerve in the intestines and uterus; and branches of the sacral plexus and the sympathetic nerve in the urinary bladder and rectum,) on the one hand, and the motor nerves of the respiratory muscles (the facial accessory. and certain spinal nerves,) on the other; while the spinal nerves that go to the extremities are excluded from this harmony of action. There are, however, certain states of irritation of the spinal cord and brain, produced by the action of narcotic poisons, or other causes, in which every impression on a sensitive nerve is capable of exciting the spinal marrow to a discharge of motor influence by all the motor nerves, even by those which are least prone to be affected by reflex action,—namely, the motor nerves of the extremities. Volkmann has shown that even dividing the spine longitudinally does not prevent the extension of the reflex motions to the muscles of both sides of the body, so long as the two halves of the spinal cord remain connected at any one point.

With reference to the question, how far true sensation is engaged in the production of the reflex motions, Volkmann inclines to the opinion of Whytt, that the motions consequent on impressions are the result of an appropriate voluntary reaction of the sensorium excited by sensation; and Müller holds that this is indubitably the case in many instances, as in those reflex phenomena which occur in an unimpaired state of the brain and spinal cord, viz: the closure of the eyes under the stimulus of a strong light, and the action of the respiratory muscles induced by irritation of the mucous membranes of the respiratory organs, intestinal canal, or urinary system. But the continuance of reflex actions, after division of the spinal cord into several portions, each part if it still contain a fragment of the spinal cord, still evidencing reflex motions, indicates that the preceding view is not applicable to all cases. The reflex phenomena are observed also to occur in parts withdrawn from the influence of the will, such as the intestinal canal and heart. The spasms also, which are excited by the stimulus of a sensitive nerve in animals in a state of narcotization, do not in the slightest degree resemble the phenomena of spontaneous reaction

Müller thus expresses his view of the reflex actions:—*Irritation of sensitive fibres of a spinal* *nerve excites primarily a centripetal action of the nervous principle, conveying the impression to the spinal cord; if this centripetal action can then be continued to the sensorium commune, a true sensation is the result; but if, on account of division of the spinal cord, it cannot be communicated to the sensorium, it still exerts its whole influence upon the spinal cord. In both cases, a reflex motor action may be the result. In the former case. the centripetal action excites, at the same time, sensation; in the latter case it does not, but is still adequate to the production of reflex motion, or centrifugal reflection.*

Müller affirms that Dr. Hall's theory differs from that of Whytt, as well as from his own, and is peculiar. In the first place Dr. Hall, limits the phenomena of reflex action to the spinal nerves, and denies to the cerebral nerves of special sense the power of exciting them. He supposes the reflex motor actions to be in no case excited by sensation, nor even by means of the nervous fibres. He maintains the existence of special nerves, or nervous fibres, endowed with the "excito-motory" function: and the reflex action he supposes to be conveyed, not by the nerves of spontaneous motion, but by special fibres, which he calls "reflecto-motory." The posterior roots of the spinal nerves, and nerves of the medulla oblongata, according to Dr. Hall. contain sensitive and excito-motory fibres, ; the anterior roots spontano-motory and reflecto-motory fibres; the vagus, too, he regards, not as a nerve formed chiefly of sensitive fibres, but as an excito-motory nerve; for in an experiment performed by himself and Mr. Brighton, its division gave rise to no pain, but affected the movement of respiration. Volkmann disputes the validity of the views of Dr. Hall, and among other arguments states, that Dr. Hall is incorrect in asserting the vagus to be insusceptible of painful sensations.

Müller distinguishes two principal grounds of reflex motion :—

1. Reflex motions of the animal system, wherein he reckons the reflex motions of the muscles supplied with cerebral and spinal nerves, the centripetal excitation may be produced in the animal or organic nerves, in the external skin, or in the intestinal canal.

2. Reflex motions of the organic system. To them belong, according to him, the reflex motions of the involuntary moving muscles; the centripetal excitation may now be transferred, first, to the brain and spinal marrow from cerebral and spinal nerves, or may have proceeded from organs, which are provided from the organic nervous system.

The laws of reflexion, which were established in the case of the cerebro-spinal nerves, hold good, according to Müller, likewise with respect to the sympathetic nerves; that is, violent impressions of sensation in parts supplied by the sympathetic may, when transferred to the spinal marrow, produce motions in parts supplied by cerebro-spinal nerves. Reflexion from impressions of sensation in parts provided by the sympathetic to the spinal marrow, and brain, and from thence to the motory action of the sympathetic, takes place also, but in a less degree, than in the cerebro-spinal nerves. The reflexion also of effects or actions, which proceed from the cerebro-spinal nerves, are transferred to the spinal marrow, and from thence to the sympathetic nervous system. A reflecting power in the ganglia, in the case of sympathetic sensations, according to Müller, is not proven, and several facts are opposed to it. He even assumes it as probable, that the brain and spinal marrow are the connecting medium, when secretions follow in distant parts after sensations through reflexion.

In order clearly to understand Müller's views, concerning reflex motion, it is necessary to consider how, according to him, the voluntary motions take place; in connection with his views of the physiology of the spinal cord. Thus the spinal nerves are capable of voluntary determination, in this way; the fibres of the spinal nerves ascend upwards in the spinal marrow, and are exposed to the influence of the will in the medulla oblongata, the source of all voluntary motion. On the other hand, the activity of the motory cerebral nerves receives the impulse to voluntary motions from the medulla oblongata. It may be supposed that, in this part of the brain, the fibres of all the motory cerebral nerves and of the spinal nerves are unfolded. The will puts these fibrilous origins into action, like the keys of a harpsichord. To the voluntary motion, there is wanting. only the excitement of a vibration or an oscillation in the origins of a certain quantity of the fibres of the medulla oblongata. All the rest is mere mechanism. Müller designates the brain as the source of sensations and voluntary motions, when he says: the brain receives the impression of all the sensitive fibres of the entire system, becomes conscious of them, and knows the place of the sensation, according to the affection of the various primitive fibres: the brain again excites the motory powers of all the motory primitive fibres and of the spinal marrow in the case of voluntary motion. So various is the power, and still so similar is the action of the brain in exciting a certain part under the immense number of primitive fibres to the playing of a many-stringed instrument, the strings of which sound as the keys are touched. The mind is the performer, the primitive fibres of all the nerves, which are diffused over the brain, are the strings, and the commencement of these are the keys. In man and the higher animals, the spinal marrow, according to Müller, bears exactly the same relation to the brain, that all the cerebral nerves bear to it, and the spinal marrow is to be considered as the common stock of all the nerves of the trunk, though it still possesses peculiar powers over the nervous stems. The spinal marrow represents not only all the nerves of the trunk in general in the brain, but also the individual primitive fibres of the nerves of the trunk. The primitive fibres of the nervous stocks which enter into the spinal marrow, proceed in a direction parallel to each other, as in the stock of a nerve, to the brain, in order that thus isolated and separated, they may impart to this organ local sensations, and that in this isolated state also they may receive excitation for motion. For according to Müller, if the primitive fibres of the nerves were bound together in the spinal marrow, a local sensation in the trunk would be just as little possible, as a separate and isolated contraction of separate muscles in the trunk. The seat of the sensations, is neither in the nerves, which bring to the brain the oscillations or vibrations of the nervous principle, necessary thereto, nor in the spinal marrow, which conducts these effects or actions, like nerves to the sensorium commune; this takes place only through the action of the fibres of the nerves and of the spinal marrow on the sensorium commune. But the spinal marrow serves not only as a conductor of the fibres of the nerves to the brain, but appears also as part of the central organ. As such it possesses the power of reflecting the sensorial irritations of its sensitive nerves to the motor nerves. It possesses also the property, whereby motions, follow a sensation, without both kinds of nerves communicating by their primitive fibres, a property possessed by no nerve that is separated from the central parts. The spinal marrow is capable of reflexion from nerves of sensation to nerves of motion without itself possessing sensation.

Johann Wilhelm Arnold,[*] in his masterly examination of the theory of the reflex function, urges the following objections against the preceding theory of Müller, concerning the structure and function of the spinal marrow.

1. A careful anatomical examination shows no such structure of the spinal marrow, as described by Müller. In contradiction to his assertions, it may be stated, that the spinal marrow does not diminish downwards in proportion as it gives off nerves which would be the case, if it were the union of the primary fibres of the spinal nerves; the fibres of the spinal nerves cannot be traced far into the spinal marrow; the fibres of the spinal marrow, which can be demonstrated only in the white substance of the same, cannot be traced up to a certain point of the central organ; it is difficult therefore to determine the place where Müller's harpsichord is to be found, whose chords are the primitive fibres, and whose keys the mind sets in motion.

2. Lesions in the spinal marrow contradict Müller's theory: thus on injuring one-half of the spinal marrow, we do not always observe paralysis of the parts of the same side, which lie below the seat of the lesion; softening of the spinal marrow does not always destroy sensation in the parts which receive their nerves from it.

3. Experiments on animals according to Arnold, afford decisive proof that Müller's theory concerning the conducting power of the spinal marrow is erroneous; thus Volkmann's experiments have shown that a longitudinal division of the spinal marrow does not prevent the extension of the reflex motions to all the muscles of both halves of the body, so long as any one part of the proper spinal marrow remains connected in the middle line. Arnold has repeatedly observed the following facts in his experiments on the action of nux vomica on the spinal marrow, which he thinks peculiarly adapted to refute Müller's theory; the cutting out of a piece of the spinal marrow on one side, does not prevent the conducting power of this part of the nervous system; the same power still continues with respect to the impressions from without inwards, if the upper part of the spinal marrow is connected with the lower only by means of a small bridge, or even when an irritation of the medulla oblongata no longer readily communicates itself to the part of the spinal marrow lying below the section. After cutting out a piece of the spinal marrow on the one side, an impression made on the sound side, is more rapidly and better conducted than on the injured side; still, on the latter side also, the conducting power is quite manifest, and not very much weakened. When after cutting out the piece, nux vomica is applied, tetanus sometimes occurs about a moment earlier on the uninjured side. The hind legs also are in several cases directed to this side. This however, is by no means constant, and never of long duration.

With reference to the theory of reflex action, as expounded by Marshall Hall, John William Arnold, remarks, that as Dr. Hall himself has declined to demonstrate anatomically his excito-motory system, and even confesses his inability to do so, he finds it unnecessary to trouble himself with showing the impossibility of the existence of such a system, by the known structure of the spinal cord. He therefore contents himself with an examination of the experiments of Dr. Hall, in support of his theory, and concludes that these experiments prove nothing farther than that the spinal marrow and medulla oblongata have a sensibility for irritants, which act immediately on the same, that these irritants are capable of throwing this into a condition which, being transferred to nerves of motion, dispose these to excite motions; further, that the irritants which affect the sensitive nerves belonging to the spinal marrow, in like manner, occasion in this central portion of the nervous system, a state which is followed by motions.

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[*] Die Lehre von der Reflex—Function für Physiologen und Aerzte; Dargestellt beurtheilt, von Johann Wilhelm Arnold. Med. Chir. Rev., Jan. 1843, pp. 33, 56.

According to Mr. Arnold the facts and the conclusions immediately to be drawn from them, were long known to physiologists, and only the consequences which Dr. Hall considered himself justified in drawing are new and also unfounded. Mr. Arnold expresses the belief that all the experiments of Marshall Hall, taken together, do not contain a single fact which can fairly be deemed a proof of the existence of an excito-motory system, and that the admission of such a system is not supported by any other kind of physiological proofs, and that it cannot as Dr. Hall conceives, be demonstrated anatomically, and therefore that we are perfectly warranted in rejecting the theory of an excito-motory system, as a system destitute of all experimental and truly rational grounds. Having thus disposed of the substance or essence of the system, Mr. Arnold thinks it unnecessary to treat of the consequences deduced from it, and he proceeds to direct attention to some errors and contradictions involved in the theory, and endeavours to demonstrate the groundlessness and untenability of the distinction of the nerves on the one hand into sensitive and excitory, and on the other hand into such as serve for voluntary motion and reflection.

The following facts disposed Mr. Arnold to admit against Dr. Hall, that both processes, sensation and susceptibility of excitation on the one side, as well as voluntary motions and reflex motions on the other, are effected by the same nerves:

1st. The skin, the organ from which sensations attain consciousness in so high a degree, which as an organ of feeling, is the medium of so many sensations, is also the organ, whose irritation calls forth the so called reflex motions, more than those of most other organs, more for instance than those of the muscles. It is accordingly here the organ through which conscious sensations are chiefly communicated, and that also through which the reflex motions chiefly receive their excitations. The nerves which go to the skin are accordingly sensitive and excitory nerves.

2d. In admitting special sensitive and excitory nerves, a general expansion of both nerves, even to the most minute ramifications, must be allowed to exist in the skin, even the smallest portion of which possesses sensibility and power of excitation. For as no portion of the skin, however small, can be touched with the finest point of a needle, which does not excite sensation, and at the same time the so-called reflex motions in decapitated frogs, it must be admitted, as Volkmann has well observed, that every part of the skin of the size of a needle's point contains two specifically different nervous fibres, and to every muscular fibre, which is subservient to voluntary and the so-called reflex motion, there belongs besides a cerebral fibre also a spinal fibre.

3d. After dividing the posterior roots of the nerves given to the posterior extremities, the animals not only lose sensibility in these parts, so that no indications of pain are observed in pinching or pricking the same, but also in irritating them none of the so-called reflex motions follow, nor on the application of nux-vomica does tetanus take place, whilst after irritation, those parts whose sensitive nervous fibres were not divided, this state immediately takes place.

4th. Nux vomica exalts so very much the power of sensation and [illegible] and the susceptibility to excitation after the removal of the head, that Dr. Hall numbers it among the poisons which produce an excess of reflex action. This fact renders it so much more probable, that sensation and [illegible] excitation are not effected by different nerves and parts of the nervous system [illegible]. After removing the head [illegible] excitation still exists and [illegible] a result very striking in amphibious animals.

After injuring [illegible] the so-called reflex motions are weaker and [illegible] animals. The same thing [illegible] The experiments of Mr. Arnold on frogs gave in general the following results. Removal of one lateral half of the [illegible] susceptibility [illegible] The action [illegible] the medulla oblongata does not [illegible] the skull and the [illegible] these [illegible] after removal of the medulla [illegible]

According to Mr. Arnold [illegible] through which the sensation [illegible] at least [illegible] great [illegible] of the nervous [illegible] in so high a degree, are also in the [illegible] increases the susceptibility to excitation.

From his experiments, as well as from the circumstance that the tetanus occasioned by the application of the nux-vomica still continues if the medulla oblongata is not removed until after the action has set in, the following conclusion may be drawn: That the spinal marrow is not active from its own intrinsic powers, and that it re-acts only so far as it is charged from the medulla oblongata, and according to the manner in which this charging has taken place the so-called reflex motions still continuing after the removal of the medulla oblongata, may be considered as charges of the nervous fluid accumulated from the spinal marrow, previously transferred from the medulla oblongata. This view, however, is but partially correct; for, besides the structure of the spinal marrow, and many physiological facts, it is opposed by the circumstance, that certain agents still act on it after the medulla oblongata has been removed; Strychnine, for instance, is still capable of exciting rigid spasms under favorable circumstances.

Müller does not express himself very definitely as regards what takes place in the spinal marrow in the reflex motion. According to his view, an irritation of a sensorial spinal nerve next causes a centripetal action of the nervous principle to the spinal marrow. If this can reach the *sensorium commune*, a conscious sensation is produced. But if it does not reach the *sensorium commune*, in consequence of a division of the spinal marrow, it still retains its entire power as a centripetal action of the sensorial nerve to produce a reflex motion. In the first case, the centripetal action would be at the same time a sensation, in the latter case not, but it is sufficient for the reflex motion, or for the centrifugal reflexion. But we are not here told in what way the centripetal action, which does not reach to a conscious sensation, brings about a centrifugal reflexion, and wherein the process effecting this in the spinal marrow differs from that in the brain in the motions attended by conscious sensations. From more than one passage in Müller, it appears that he assumes that in the spinal marrow there is a mechanical transference of the nervous fluid from the nerves of sensation to those of motion. This assumption, however, according to Mr. Arnold, is contradicted, not only by all the facts above adduced to disprove the isolated conducting property of the nervous fibres in the spinal cord, but also, by the experiments which show that the motions of irritation of decapitated animals evince the character of determinateness and harmonious accordance.

From the results of his experiments, Mr. Arnold drew the following conclusions:

1. A power to feel external irritants has its seat in the spinal marrow, in some degree independently of the brain and medulla oblongata, *the perceptive faculty of the spinal marrow.*
2. This power in the spinal marrow regards not merely the irritant in general, but also the kind, the degree and the locality of it. But the property of perceptions connected with consciousness is wanting.
3. Next to the perceptive faculty (the faculty of feeling), is the faculty of the spinal marrow to re-act correspondingly to excitement occasioned by impressions, and, in consequence of this, to perform suitable, combined and harmonious motions, *the re-active faculty of the spinal marrow.*
4. These motions are no doubt suitable and harmonious, still they want the character of freedom. They are not external manifestations of a will.
5. The spinal marrow possesses only in a slight degree the faculty of accomplishing spontaneous motions. If, in decapitated animals, self-dependent motions follow, they are principally the consequence of a disposition or excitation, which the spinal marrow has received from the brain or medulla oblongata previous to decapitation.
6. The degree of the perceptive faculty of the spinal marrow depends on a peculiar disposition of this organ, which is effected in it principally by the medulla oblongata, and which without it, can be produced in this organ only in a very slight degree. The same may be said of the rapidity and violence of the motions occasioned by external irritants.
7. The disposition produced in the spinal marrow in this way, continues for some time in it, if it be separated from the brain and medulla oblongata, and even in separate parts of the same.
8. That which takes place in the spinal marrow, during the perception of external influences, and the determination of motions following thereon, is analogous to that which takes place in the brain during conscious sensations and voluntary motions, only that clear consciousness and freedom of the will are wanting to it, whilst the character of suitableness and of harmonious accordance appertains to it in the highest degree.
9. The impressions which the central organs receive through the nerves, produce in them a condition or disposition corresponding to their quality, depending both on the nature of the impression, and the nerve by which it is taken up and conducted to the central organs of the nervous system, whereupon these organs re-act in a corresponding manner.
10. A mere transference of the nervous principle from sensitive to motory fibres does not take place in the spinal marrow. The term "reflex function," does not indicate what takes place in this organ during the motion occasioned by external irritants.
11. With regard to the conducting faculty of the spinal marrow, observation goes to show that it is in its total character, in its character as a *whole*, that it imparts the condition,

in which it is placed on the one hand by the brain and the medulla oblongata, and on the other hand by the nerves. After what has already been said, it can no longer be admitted that the fibres of the spinal marrow conduct impressions separately and isolatedly, just like the nervous fibres.

12. It is not the number of the muscles moved that the central organ determines, but the end which is to be attained. A harpsichord theory, as it has been introduced of late years, has no facts for and many facts against it. (Med. Chir. Rev., January, 1843, pp. 33-55.)

It is evident therefore that the theory of Dr. Hall, that the nervous fibres engaged in the production of the reflex or excited movements, are distinct from those which reach the centres of sensibility and volition in the brain, was not established by the facts which he himself adduced in its support. In fact Dr. Hall, himself, admited the impossibility of demonstrating anatomically the existence of his excito motory system of nerves, and he inferred their existence from the results of physiological experiments, which as we have just seen by a review of the experiments and arguments of Mr. Arnold, admitted of another explanation. Some light however has been thrown upon the probable existence of reflex or excito-motor nerves, by the observations and arguments of Mr. Grainger, Dr. Carpenter and Mr. Newport.

Mr. Grainger (Observations on the Spinal Cord, London, 1837,) sought, first to prove that gray matter is the source of all power in the nervous system, and that the white fibres are merely conductors: supporting this view by the fact that the nerves are rendered incapable of performing their functions by separation from the central organs: that the power of those central organs is always proportionate to the quantity of gray matter which they contain: that the abundance of gray matter in the brain, for example, bears a direct relation to the development of the cerebral faculties, and its abundance in the spinal cord, to the motor powers of the animal: and lastly, that even in particular parts of the cord where large nerves enter and issue, a corresponding increased deposit of gray substance is found. In the next place, Mr. Grainger directed attention to the roots of the spinal nerves, and showed that while a portion of the fibres of each root is derived from the white fibrous substance of the cord, another portion passes inwards, and is lost in the gray matter, as had been before stated by Bellingeri and Weber. The latter fibres Mr. Grainger regarded as the true excito-motory, and reflecto-motory fibres, the former he supposed to be the conductors of sensation and volition ascending to or descending from the brain. These views he extended to the cerebral nerves, and stated that they also may be traced to have origins both from deposits of gray matter when the impressions conveyed by incident fibres are communicated to reflex motor fibres, and also from the white substance which passes up to the hemispheres of the cerebrum and cerebellum. Lastly Mr. Grainger pointed out the accordance of Dr. Hall's theory, with the structure of the nervous system in the lower animals, and especially the invertebrata.

Dr. Carpenter, in his Inaugural Dissertation on the Nervous System of the Invertebrata, (Edinburgh 1839,) expressed views essentially the same as those developed by Mr. Grainger.

The following are some of the most important physiological inferences, deduced by Dr. William B. Carpenter, from the structure of the nervous system in the invertebrate classes of animals.

The actions performed by the lowest animals have almost entirely the character of reflex movements, the manifestations of true sensibility and volition which they present being very few. The earliest form of nervous system met with in these animals consists of ganglia with nerves which convey to them the impressions made by external agents, and others which conduct the reflex motor influence; the principal sets of organs with which such ganglia are connected being those which minister to the functions of the ingestion of food, respiration, and locomotion. In proportion, however, as the development of organs of sense and the character of the movements prove the participation of the faculties of true sensation and volition in the acts of the animal, particularly in those by which food is acquired, certain ganglia, connected with the organs of sense, and like them, always seated near the mouth acquire a larger size, and an evident predominance over the rest. Yet, even where this is the case, as in the higher Mollusca and Articulata, the organs by which the food is introduced into the stomach, the organs of respiration and those of locomotion, still remain under the immediate influence of special ganglionic reflecting centres, while distinct fibres descend from the cephalic ganglia and unite with nerves issuing from these local nervous centres, for the purpose of conveying to the different organs the influence of the will, and receiving the impressions destined to produce sensations. Thus the nervous cord in the arm of the Cuttle-fish, is composed, according to Dr. Sharpey, of two fasciculi of fibres, in one of which ganglia are formed at points corresponding to the prehensile suckers, while the other passes over the ganglia without entering into their composition. The ganglia of this nervous cord are, evidently centres of reflection: for, when the arm is separated from the body of the animal, each sucker may be stimulated to contract: in order however that they may act in unison, these reflecting ganglia are connected by a fasciculus of commissural fibres, while at the same time, the muscular apparatus of the suckers and of the whole arm is brought under the control of the will through the medium of the non-gangliated band, which descends from the cephalic ganglia. The same remarks apply to the abdominal nervous cord of the Articulata, which has been shown by Mr. Newport (Phil. Trans., 1834) and Dr. Grant, (Lancet, July, 1834), to consist of two pairs of fasciculi, one inferior, in which the ganglia are formed, and the other superior, which passes over the ganglia of the cord apparently without entering into their composition. The latter fasciculus, according to Dr. Carpenter, contains the true conductors of sensation and voluntary power, while the inferior fasciculus has the function of connecting the different locomotive ganglia, for consentaneous action. In like manner, a part only of the fibres given off by the nervous cord is supposed to reach the cephalic ganglia through the medium of the superior fasciculus, while another portion terminates in the local ganglia which form their reflecting centres.

These views respecting the nervous system of invertebrate animals appear to be confirmed by the results of microscopic examination of the ganglia and by the results of certain experiments. Thus Dr. Carpenter adduces the following microscopic observations by M. Leuret and himself; in the ganglia of Mollusca, the fibres of the nerves according to Leuret (L'Anatomie Comparée du Système Nerveux), terminate in the midst of the gray matter, in the Leech, he describes and figures the fibres of the nerves which enter each ganglion of the ventral cord, as being continuous in part with the longitudinal fibres of the cord, and in part with those of the corresponding nerves entering the opposite side of the ganglion; Dr. Carpenter states, that in the Myriapoda, each nerve given off by a ganglion of the ventral cord has three series of roots, one of which terminates in the gray matter of the ganglion; another interlaces with those of the opposite side; whilst the third is continuous with the fibrous portion of the cord, which may be traced uninterruptedly to the cephalic ganglia. Valentin, some time before, had found in the microscopic examination of the ganglia of the nervous cord of the Leech, that while the longitudinal fibres of the cord were continued, in part, at least, uninterruptedly over each ganglionic mass, those of the lateral nerves spread out in its substance and *appeared* to terminate there. We have already examined at length the first papers of Mr. Newport, who affirmed that he had distinctly seen commissural fibres passing between the nerves of opposite sides in the ganglia of the cord of Insects. There appears, therefore, sufficient direct evidence, to prove that many of the nervous fibres which enter the ganglia of the body of Invertebrate animals, are not continued to the cephalic ganglia which represent the brain of the higher classes.

That the ventral cord of Articulate animals is a source of motor power, is sufficiently proved by the well-known occurrence of automatic and reflex movements in these animals after decapitation or division into several segments.

The elucidation of the properties of the different parts of the cord in these animals, still remained an interesting subject for investigation. Dr. Hall stimulated one of the nerves coming off solely from the superior non-gangliated column of the lobster; the muscles to which it was distributed, and they alone were contracted. He then stimulated one of the nerves which arise from the ganglia; muscles both anterior and posterior to the part stimulated were excited into combined action. Valentin, in his experiments upon the Astacus Fluvitalis, found that irritation of the nerves arising from the ganglion itself, sometimes produced motions, but not invariably, while irritation of the nerve given off by the superior non-gangliated fasciculus of the cord always excited musular contractions. Valentin having divided the abdominal cord just below the thorax, irritated the superior fasciculus of its lower portion; muscular movements were very frequently excited. He irritated the inferior fasciculus; no such result followed. The strongest and most extensive motions were, however, produced when the abdominal surface of one of the ganglia was irritated; almost all the muscles of the tail being thrown into action by stimulating one ganglion.

Dr. Wm. Baly, the learned and acomplished translator of Müller's Elements of Physiology, in conjunction with Mr. Newport, verified the preceding statement; they found that lateral compression of a ganglion, or irritation of its lower surface, in the tail of a Lobster, separated from the body of the animal, caused contraction of muscles situated both before and behind it, and violent movements of the whole tail. Dr. Baly drew from these experiments the following conclusions:

1. The superior fasciculi of the ventral cord of Articulata, and the nerves which arise from it alone, contain motor fibres,—probably fibres subservient to volition. 2. The ganglia of the cord are centres of motor influence, and give rise to movements through the medium of efferent fibres, not only when subjected to direct irritation, but also, as Dr. Hall's experiment seems to show, when an impression is conveyed to them by afferent or incident fibres contained in the nerves which arise from them. 3. The effect of irritating a ganglion, or the excito-motory nerves arising from it, is not necessarily confined to that ganglion; but may extend to other ganglia situated anteriorly or posteriorly, through the intervention of the inferior fasciculus of the cord. Mechanical irritation of the inferior fasciculus itself, after its division immediately behind a ganglion, does not, according to Valentin, excite movements. Mr. Newport and Dr. Baly, however, found that lateral compression of the entire cord in the lobster, gave rise to muscular contractions in segments both anterior and

posterior to that in which the irritated part of the cord lay, though the convulsions were in this case not so energetic as when the ganglia themselves were compressed. Valentin states also, that the struggles of the animal, when the inferior fasciculus or the ganglia of the cord, as yet in connection with the cerebral ganglia were touched, evinced the true sensory endowments of these parts. (Elements of Physiology, by J. Müller, M. D., etc. Translated by William Baly, M. D. Sec. Ed., Vol. 1, pp. [illegible].)

To physiologists who regard the cephalic ganglia of the invertebrata as the special seats of volition and the perception of sensations, the small size of the filaments connecting these ganglia with the rest of the nervous system in most of the Articulata and many Mollusca, must alone appear almost sufficient proof that a great part of the fibres entering and issuing from the different nervous centres of the body, are distinct from the sensitive and volitional fibres. That the cephalic ganglia are the centres of sensibility and volition, is rendered probable, both by the history of their development in the animal series, where their size is proportionate to the perfection of the sensorial and voluntary faculties, and by their special structural relation to the other ganglia.

Mr. George Newport, President of the Entomological Society of London, communicated to the Royal Society, on the 6th of April 1843, a paper "*On the Structure, Relations and Development of the Nervous and Circulatory Systems, and of the Existence of a Complete Circulation of the Blood in Vessels, in Myriapoda and Macrourous Arachnida,*"* which contained valuable additional observations, bearing upon the reflex theory of Marshall Hall.

According to Mr. Newport, the formation of the great abdominal cord in the Julidae, by the lateral approximation of two distinct portions, is indicated in its upper surface by a slight median sulcus, and on its under surface by a slight longitudinal division, between the two approximated ganglia, that form each of its enlargements. Each of these lateral divisions of the cord in Julus, as formerly shown in Scolopendra and other Articulata, is a compound structure formed of two distinct longitudinal series or columns of fibres, which, notwithstanding the different explanation that has been given of their function, since they were first described by Mr. Newport (Philosophical Transactions 1834, Part II., p. 405), are quite distinct from each other, although closely approximated together. By the aid of means superior to those formerly employed in his investigations, Mr. Newport found that the abdominal cord contained other structures besides those already described. In his former communication to the Royal Society, Mr. Newport indicated the existence of fibres that run transversely through the ganglia of the cord, in the larva of the common butterfly (and similar structures have since been shown by Dr. Carpenter (*Inaugural Dissertation on Nervous System of Invertebrata*), in other Articulata, and applied by him to explain some of the reflex phenomena of the nervous system, in accordance with the theory promulgated by Dr. Marshall Hall). But besides these two sets of *longitudinal fibres*, and the series that pass *transversely through the ganglia*, Mr. Newport discovered other structures in the cord that had hitherto been overlooked. There are fibres that run longitudinally in part of their course, at the sides of the cord, and enter into the composition of all the nerves from the ganglia, and are designated by Mr. Newport as *fibres of reinforcement* of the cord.

According to Mr. Newport, every nerve from a ganglionic enlargement of the cord is composed of four sets of fibres: an upper and an under one, which communicate with the cephalic ganglia; a transverse or commissural, that communicate only with the corresponding nerves on the opposite side of the body; and a lateral set that communicate only with the nerves from a ganglionic enlargement on the same side of the body, and form part of the cord in the interspace between the roots of the nerves. It is by the successive addition of these lateral portions of the cord, that its size is maintained almost uniformly throughout its whole length in the elongated bodies of the Myriapoda. With reference to the identification of the *fibres of reinforcement of the cord*, Mr. Newport states, that their separate existence is indicated chiefly at the postero-lateral margin of the ganglia, where they are seen to form part of the nerves and cord, without passing towards the brain. In other parts of their course they are not distinguishable by color, and very rarely by any longitudinal line of separation from the fibres which form the inferior longitudinal series, or portion of the cord, to which they are approximated; but from which they are believed to be distinct, from the fact that they do not ascend with them to the brain. Their function must be regarded only as *reflex*; entirely independent of sensation, but capable of being excited into action by external causes. Mr. Newport announced that the existence of the lateral fibres in the cord, fully explained the reflected movements of parts anterior or posterior to an irritated limb, on the same side of the body, as the commissural ones do the movement of the parts on the side opposite to that which is irritated.

After a careful examination of the mode of development of the spinal cord, Mr. Newport concluded that the cord is elongated in the ganglia, by extension or growth longitudinally, and that hence the ganglia must be regarded as performing a most important office in the nervous system, that of being centres of growth and nutrition to the cords and nerves. The *structure* of the ganglia confirms these conclusions, and shows that not only are these parts centres in which the reflected motions of the limbs are effected, but that they are even of more importance, being those in which the structures themselves are nourished.

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* Phil. Trans., 1843, p. 243–302.

Although Mr. Newport pointed out the existence of fibres in the nervous cord of Myriapoda and Arachnida, which lead to the conclusion, that the doctrine of the individuality, or special function of each fibre is correct; that there are fibres in every nerve derived from two distinct portions of the cord, which from their direct communication with the brain, from one end of the body to the other, are believed to minister to volition and sensation; and that other fibres also exist in the same nerves, that have no communication whatever, with that organ; and further, that some of these, which are extended transversely across the body, influence both sides of those individual segments to which they are distributed, and those only, while others combine in action two or more contiguous segments, but only by direct influence on one side of the body: it yet remained to be shown by experiment, whether the assignment of certain functions to these parts of the nervous system, in these inferior animals is correct; whether the results of experiments on these worm-like beings agree in principle with the experiment already made by many physiologists on the vertebrated classes, and those which the pathology of disease has afforded in man himself; whether, as leading to these important results they coincide with the first experiment made on one of the crustacea, conjointly by Dr. Hall and Mr. Newport, in the spring of 1834, (Lectures, Lancet, February 3d, 1838, p. 650, Memoirs on the Nervous System, p. 67,) and with others subsequently performed by Valentin (De Function Nervorum, Bun. 1839, also Baly's Müller) on the same animal, and afterwards repeated by Dr. Baly and Mr. Newport, in 1840 (Muller's Physiology by Dr. Baly, Sec. Ed. Vol. 1, 1840, p. 771;) and lastly, whether the seat of sensation and volition is confined entirely to the supra-œsophageal ganglia, the brain in these Articulata.

No experiments had as yet been made on any of the Myriapoda with reference to these inquiries, save only one, imperfectly described by Dugés (Traité de Physiologie Comparée, tom. 1, p. 162;) hence it became especially necessary, that with this object the inquiries of Mr. Newport should be extended to these lower forms of life, so far removed from those on which experiments had already been made, and in which from their low organization, the phenomena may be well studied. With this object Mr. Newport made careful experiments on one of the lowest of the Chilognatha (*Julus terrestris*,) and one of the highest of the Chilopoda, (*Lithobius forficatus*.)

The questions which Mr. Newport proposed for examination, were:

1st. Whether sensation and volition are confined to the supra-œsophageal ganglia, the brain, or whether they exist also in the first sub-œsophageal ganglion, or in the other ganglia of the cord?

2d. Whether these functions are destroyed by partial destruction of the brain?

3d. Whether there is any direct evidence of sensation in a portion of the cord that is insulated from the brain?

4th. Whether the movements in these animals, when deprived of the brain, are identical with those of the Crustacea and Vertebrata?

These experiments lead Mr. Newport to the conclusion, that the seat of volition is solely in the supra-œsophageal ganglia or brain of these animals, since all direction of purpose, all avoidance of danger, all control over the movements of the body, either of speed or change of direction, are lost when they are much injured or removed. Volition ceases quickly when they are severely wounded, and is greatly diminished even when only one is slightly affected. This latter fact is indicated by the loss or diminution of purpose, and by the gyratory movements of the body.

These experiments also lead to the conclusion, that all the phenomena which occur in the posterior parts of the body, after the brain and cord have been separated, are reflex or excited, and that these are most intense in the two extremities of the cord—the medulla oblongata and the terminal ganglion; and further, that the reflex phenomena are always excited, and do not occur spontaneously, and that their intensity is greater in proportion to the stimulus applied, and gradually diminishes until they entirely cease or are re-excited precisely as already shown by Dr. Hall in the vertebrata.

The experiments, both on the Julus and Lithobius seem further to show, that the reflected movements cease first in the anterior part of the cord and its ganglia, and that they are retained longest in the posterior; that the movements are more powerful and continue longest when the cord is entire, the brain alone being separated from it; and that they entirely cease sooner in proportion to the greater number of parts into which the cord is separated; further also, that the reflex phenomena are less readily excited in the anterior part of the cord, while it is still in connection with the brain, and that they cease entirely soon after the cessation of volition in that organ; and in those experiments in which only a very short portion of cord was removed with it from the body.

Many of the phenomena are precisely similar to those which have hitherto been observed in the Crustacea. They agree in the circumstance that violent contractions of the segments and limbs, both anterior and posterior to a ganglion, are induced by irritation of that ganglion, both when connected with the brain and when isolated from it, thus proving these movements in the latter instance to be reflex; but there is as yet no direct proof that sensation does not also exist in these ganglia.

The general results of these experiments tend to confirm the belief that the fibres pointed out by Mr. Newport in the commissures of the cord and ganglia, and which cannot be traced to the brain, are those by which the reflex movements are maintained independently of this organ. Mr. Newport confirmed the correctness of these conclusions by subsequent and still more extended experiments upon the Coleoptera, Orthoptera, Hymenoptera, Neuroptera, Diptera, and other segmented insects. (Phil. Trans., [illegible].)

It has been long recognized that the spinal cord of the higher animals might be regarded as containing a succession of independent reflecting centres, for the reflecting action of the centres or segments of the cord seemed explicable without admitting Dr. Hall's theory of the existence of special incident and reflex fibres. Even when Mr. Grainger pointed out the accordance of that theory with the mode of origin of the spinal nerves, it still appeared possible that the fibres which entered the gray substance of the cord might, through the medium of it, act on each other and nevertheless be afterwards continued upwards to the brain. When, however, the existence of two distinct classes of fibres, those for sensation and volition, and the fibres which are engaged in the production of the reflex movements, appeared to be demonstrated in the invertebrate classes, and Dr. Hall's theory might therefore be regarded as applicable to these animals, there appeared to be no reason for the adoption of a different explanation of the phenomena in the vertebrata, when the function and intimate structure of the nervous system are in all other essential points the same.

It remains, therefore, that we should in the next place examine carefully the results of the microscopical and anatomical investigation of the minute structure of the spinal cord and brain in vertebrate animals, not merely with reference to the verification of the theories of Sir Charles Bell and Dr. Marshall Hall, but also as affording the best anatomical and physiological basis for the investigation of certain pathological phenomena manifested by the nervous system in diseased states.

RESULTS OF THE MICROSCOPICAL AND ANATOMICAL INVESTIGATIONS OF THE MINUTE STRUCTURE OF THE BRAIN AND SPINAL CORD IN VERTEBRATE ANIMALS.

When the investigation was transferred to the spinal cord of man and of the vertebrata generally, the difficulties were greatly increased on account of the greater size and more complex structure of the nervous masses to be investigated, and such researches were not possible until a comparatively recent period, when both the instruments for and the methods of preparation and investigation of the nervous structures had been brought to a high degree of perfection.

It has been well said by Schroeder van der Kolk, that the examination of the minute structure of the brain and spinal cord is acknowledged as one of the most difficult investigations in minute anatomy. The peculiar softness of these parts, the fact that they are destroyed by slight pressure, the extraordinary minuteness and delicacy of their tissue, their primitive filaments being quite imperceptible to the naked eye, while it is with difficulty that, under a moderately strong magnifying power, a single thread can be followed even for a very short space,—lastly, the infinite number of the primary filaments, which in many places interlace in the most varying manner, forming a net-work incapable of being unravelled,—are so many reasons why the most persevering efforts of very distinguished anatomists have led to such varying results, and why great differences of opinion still exist in reference to the most important questions.

The communication of sensation through the spinal column to the brain, and the conveyance from thence of the orders of the mind with inconceivable rapidity to the different muscles, led to the almost universal acceptance of the doctrine, that the nerve filaments ran from their ultimate distribution directly through the spinal column to the brain; and after the brain and spinal cord had been shown by Ehrenberg to consist in their intimate structure of minute tubes, the immediate continuation of the nerves through the latter with the former appeared to have been demonstrated beyond all doubt by Valentin. Remak, who subsequently engaged in the study of the structure of the gray substance and carefully investigated the ganglionic cells with their efferent filaments, was one of the first who seems to have had some doubt as to the direct course of the nerves through the spinal cord into the brain; and Hannover, two years after [illegible], by the employment of a solution of chromic acid, detected the transverse fibrous commissures in the spinal cord of birds, frogs and fishes, and expressed the belief that the posterior fibres took their origin from ganglionic cells. In his work, *Recherches Microscopiques sur le Système Nerveux* ([illegible]), he shows the origin of the nerve fibres from the ganglionic cells in the cortical substance, and states that the fibres of the spinal cord descend perpendicularly, and curving at obtuse angles pass over into the roots of the nerves, the cerebral fibre and the nerve fibre having thus direct connection with each other. The transverse fibres he describes anew, without, however, having been able to trace them to the periphery of the medulla; a few of these would sometimes appear to bend round into the nerve roots, and portions of them he described as passing from one to the other side of the cord. He was not able to detect these transverse fibres plainly in any of the mammalia; and with the exception of isolated instances in fish; he did not observe nerve fibres arising distinctly from the ganglionic cells in the spinal cord. Stilling and Wallach on the other hand, inferred that the roots of the nerves ran transversely between the white columns of the spinal cord and the gray matter, and were merely direct prolongations of the transverse fibres of the latter, the anterior roots decussating in the middle with the posterior roots from the other side of the spinal cord. They considered that the will acted chiefly through the gray matter. In their first essay (*Ueber die Textur des* Rückenmarks, 1842) these observers appeared to confound the ganglionic cells with dilated blood-vessels; but the subsequent investigations of Stilling, (Ueber die Textur der Medulla Oblong, 1843), were much more complete and are regarded by competent anatomists to be correct. Stilling describes the multi-polar ganglionic cells, but the connection between the nerve roots and the spinal corpuscles, as he calls them, or ganglionic cells, was still unknown to him, although he expressed the opinion that they are closely connected with the motor power. Although Stilling represents with the greatest accuracy, the origin of the nerve roots from the gray substance, his investigations were on account of the low magnifying powers employed, insufficient to show the more minute connection between the nerve roots and the other fibres of the medulla oblongata; while his experiments by partial transverse sections of the spinal cord showing that reflex movement is not prevented, and that even voluntary motion remains beneath the divided part, described in an earlier essay, have had much influence in suggesting the idea of a local cross origin and decussation of the spinal nerves.

Volkmann argued that if the nerves ran uninterruptedly through the spinal cord to the brain, all the filaments which are distributed as nerves throughout the body, must be present in the upper part of the cord, and the medulla spinalis should bear resemblance to a cone, that is, the medullary matter or white columns ought to be so much thicker in the cervical portion, as would be necessary to enable it to contain all the nerve filaments; which is by no means the case. He sustained this inference, by his investigations on the spinal cord of a serpent (*Crotalus mutus*,) in which he reckoned not fewer than two hundred and twenty-one pairs of nerves, whose united thickness exceeded the circumference of the spinal marrow at the second cervical nerve more than eleven times.

The nerve roots therefore, according to Volkmann arise in the spinal cord, and do not run directly through to the brain: and he further shows, that the motor filaments at their origin in the spinal cord are so adapted, that every stimulation applied to them must produce a corresponding combination of movements. Since, he says, the application of a stimulus to the roots of the frog is sufficient to bring into motion all the corresponding motor fibres, there is no doubt that this effect may be produced by a single cerebral fibre, penetrating to the point of insertion of the allied crural motor nerves. Still less reason is there, he adds, to doubt, that a single cerebral fibre is sufficient to bring into action all the motor fibres which work simultaneously, as for example, the nerves of one and the same muscle, and which, therefore, are in all probability so arranged, as to be incapable of acting independently of one another. These observations contain the foundation of the true explanation of the course and relation of the nerve roots and the spinal cord, and had this observer been better acquainted with the relation of the ganglionic cells, their efferent filaments, and their connection with the nerve roots and other fibres of the spinal cord, he would certainly have left little for his successors to add: but circumstanced as Volkmann then was, he could explain these and other phenomena only by the hypothesis of a decussating conduction in the spinal cord, a theory incapable of satisfactorily accounting for the great regularity and steadiness of either the voluntary motions, or of the natural phenomena of reflexion, swallowing, and other such like movements.

Kölliker, endeavored, by fresh investigations and calculations, to refute the arguments of Volkmann, and to re-establish the old opinion that all nerves arise directly from the brain. That all the nerve filaments proceeding from the spinal cord may be comprised in its upper part, Kölliker endeavored to prove by fresh measurements of the thickness of the nerve roots, compared with the constant increment of medullary matter as we proceed upwards in the cord. The probability of this was, he thought, much increased, by the greater tenuity of the nerve filaments in the spinal marrow than in the nerves. With the main question, whether all the spinal nerves arise from the brain, is most intimately connected that of the use of the multipolar ganglionic cells. Kölliker assumes that these ganglionic cells are no where connected with the nerves; he found that the filaments derived from them constantly subdivide into progressively finer branches, so that if a connection with the nerves must take place, this can be the case only with the most minute ramifications. He considers it to be impossible, that a prolongation of a central ganglionic cell should pass as cylinder axis into the doubly outlined nerve fibre, although Wagner positively states that he has undoubtedly seen such to be the case, and the careful and learned observer Schroeder Van der Kolk, has more than once decidedly confirmed Wagner's observation.

It would extend this introductory chapter into the magnitude of a large volume, if we were to enter into a minute and critical examination of the labors of the various observers as R. Wagner, Budge, Stilling, Kölliker and others, and we will best serve the interests of the physiological and pathological student and practitioner ot medicine by presenting the outline of the labors of those observers as Clarke and Schroeder Van der Kolk, who have made the spinal cord a careful study during a series of years, and whose ability and methods of research have been universally acknowledged.

Mr. J. Lockhart Clarke, investigated carefully during the period of several years, and employed much time and labor in endeavoring to arrive at some well grounded and settled conclusion with reference to the difficult and intricate subject of the anatomical structure of the spinal cord; and his investigations were especially directed to a question of great interest and physiological importance, viz: whether the roots of the spinal nerves belong exclusively to the spinal cord, or whether part of them ascend within either the white or gray columns, and form the channels by which impressions are transmitted to and from the brain. At the time these inquiries were begun and nearly up to the period of their completion, Mr. Clarke had not seen any of the works of Dr. Stilling, and knew no more of his investigations into the structure of the spinal cord, than what he had gathered from the anatomical and physiological works published in England. However, nearly, therefore, a few of the facts brought forward by Mr. Clarke, in his papers, published by the Royal Philosophical Society of London, may correspond to the results of Dr. Stilling's inquiries, it is but just to state that the investigations were made without any knowledge of Dr. Stilling's views, excepting only those with regard to the origin of the spinal nerves. The observations of Mr. Clarke, were made by means of one of Mr. Ross's finest microscopes, on many thousand preparations of the spinal cord of man, of the calf, sheep, pig, dog, cat, rabbit, Guinea pig and frog, reptiles and fish.

In his first paper, (*Researches into the Structure of the Spinal Cord, Phil. Trans.* 1851, pp. 607, 621), Mr J. Lockhart Clarke illustrated and established the following facts, with reference to the structure of the spinal cord.

The posterior gray substance, at the lower extremity and in the dorsal region of the spinal cord, consists only of a single mass; and the *substantia gelatinosa*, there extends uninterruptedly across from one side to the other. The nerve fibres of the gray substance, including those of the *substantia gelatinosa*, are not gray fibres bearing nuclei, like those of the sympathetic, but fine tubules. Two considerable columns of caudate vesicles, which Mr. Clarke named the *posterior vesicular columns*, in intimate connection with the posterior roots of the nerves, extend through the whole length of the cord; commencing small at its lower extremity increasing in size in the lumbar and cervical enlargements, and terminating at the upper part of the medulla oblongata. The number of caudate vesicles, particularly in the anterior gray substance, is in direct proportion to the size of the nerves. The column of vesicles into which, in the cervical region, the spinal accessory nerve may be traced, extends down the cord as far as the lumbar enlargement. A considerable branch of the spinal accessory nerve, after entering the gray substance through the lateral column, may be easily traced to the caudate vesicles of the anterior cornu. The spinal accessory is the only nerve immediately attached to the lateral column. The posterior roots of the spinal nerves, are immediately attached to the posterior white columns only; and the anterior roots to the anterior columns only; but fibres from both these roots, after traversing certain portions of the gray substance pass out again, into the white columns. Neither the anterior nor posterior columns are connected by a transverse commissure.

The central portion of the gray substance, immediately surrounding the spinal canal, is not a commissural structure, but a layer of fine fibrous tissue for supporting the walls of the canal, which is lined with a layer of columnar epithelium. Phil. Trans. 1851. p. 607.

Mr. Clarke in his second paper "*On certain Functions of the Spinal Cord, with further Investigations into its Structure,*" Phil. Trans. 1853, pp. 347-356, examined more fully the question, whether the roots of the spinal nerves belong exclusively to the spinal cord, or whether part of them ascend within the white or gray columns, and form the channels by which impressions are transmitted to and from the brain, and also, endeavored to apply the results of his discoveries to the explanation of the functions of the spinal cord.

Many physiologists and anatomists maintain the opinion, that part of the fibres comprising the anterior and posterior roots of the spinal nerves, ascend longitudinally with the white columns, without entering the gray substance of the cord, and transmit to and from the brain, impressions which give rise to sensation and voluntary motion; and in support of this doctrine, Mr. Grainger, (*Spinal Cord*), Mr. Solly, (*Human Brain*), and Dr. J. Budge (Müller's Archiv, 1844,) have adduced the fact of having *traced* these fibres in the spinal cord of the Vertebrata, and Mr. Newport and Dr. Carpenter, (Phil. Trans. 1843), in the Invertebrata.

On the other hand, Todd and Bowman, (Physiological Anatomy, vol. 1, 1845), Stilling (Untersuchungen über die Textur des Rückenmarks, 1842), Volkmann (Nervenphysiologie, in Wagner), and others, hold the opinion that all the fibres of the spinal nerve enter the gray substance, and belong exclusively to the spinal cord.

In his first paper, Mr. Clarke showed unquestionably that to the posterior white columns, the posterior roots, and to the anterior white columns, the anterior roots of the spinal nerves are exclusively attached; while the lateral columns, to which both these roots were formerly supposed to be connected, are in immediate connection only with the spinal accessory nerve (Philosophical Transactions, 1851, Part II, p. 608). Mr. Clarke has shown that the bundles which form the posterior roots, consist of three kinds, which differ from each other partly in direction and partly in the size of their component filaments. The first kind enter the cord transversely and pursue a very remarkable course. Each bundle, after traversing the longitudinal fibres of the posterior columns in a compact form, and at right angles, continues in the same direction to a considerable but variable depth within the grey substance, dilating and again contracting, so as to assume a fusiform appearance. It then bends round upon itself at a right or more obtuse angle, and running for a considerable distance in a longitudinal direction *down* the cord, sends forwards, at short intervals, into the anterior gray substance, a series of fibres like those from the roots of plants. In this longitudinal course, it is joined by corresponding fibres from bundles above and below it, which thus contribute to form a continuous band. The fibres projecting from this band into the anterior gray substance, have the following distribution: Part of them form loops with each other within the gray substance, particularly near its border; others extend directly into the anterior white columns, etc., and bending round, both *upwards* and *downwards*, are seen sometimes to re-enter the gray substance, and form with each other a series of loops, and sometimes to continue a longitudinal course within the white anterior columns, amongst the fibres of which they become lost. Whether the latter also ultimately form broader loops, with corresponding fibres from the gray substance, it is impossible to ascertain. But even if those which *ascend* in the anterior columns are continued upwards to the brain, one can scarcely avoid inferring that those which descend re-enter the gray substance, either to form loops or to become continuous with the fibres of the anterior roots, since the whole of the latter proceed directly to the gray substance. Mr. Clarke has sometimes felt almost persuaded, that a great number of the fibres of these posterior roots are directly continuous, in the gray substance with those of the anterior roots; but he is unable to make this statement with absolute certainty, and reserves the question for future investigation. The second kind of bundles which form the posterior roots, and traverse the posterior columns transversely, and with different degrees of obliquity from without inwards, extend nearly as far as the posterior median fissure. Their component filaments are finer than those of the other kind of bundles, measuring in a recent state about the 1-7000th of an inch in diameter. They enter and pass through the posterior gray substance at various angles, and in compact bundles, which decussate and interlace each other in the most complicated manner. Some of their fibres cross over to the opposite side through the posterior commissure, behind the spinal cord; others extend into the posterior and lateral white columns; and the rest may be traced deeply into the anterior gray substance, where they separate in various directions and are ultimately lost to view.

The bundles which compose the third kind of posterior roots, enter the cord obliquely. A few of their fibres proceed near the surface, both upwards and downwards, and pass out again with the roots above and below them. The rest cross the posterior white columns obliquely, and chiefly *upwards*, a small number only passing downwards. Interlacing at the same time with each other and the roots already described, they diverge, and for the most part reach the gray substance at points successively more distant from their entrance, in proportion to the obliquity of their course; the remainder, or most divergent, taking a longitudinal course with the fibres of the posterior white columns amongst which they are lost. It is impossible to say whether any of these longitudinal fibres are continued as far as the brain, or whether they ultimately reach the gray substance of the cord. It is also extremely difficult to trace the other fibres of these roots, after they have reached the posterior gray substance. In some of the finest preparations, however, they may be seen to interlace each other in a kind of net-work. A large proportion diverge abruptly in various directions, so that in any section they are divided. Many of them, both singly and in small bundles, may be observed to form loops by returning to the white columns.

The *anterior roots* of the spinal nerves, as Mr. Clarke formerly described them, traverse the anterior part of the antero-lateral columns in distinct and nearly straight bundles. They form no interlacement with each other, like the posterior roots, until they reach the gray substance. Here their fibres diverge in every direction, like the expanded hairs of a brush. Some near the margin, are easily seen to form loops with those of continuous bundles; others run outwards to the lateral columns, and inwards to the anterior columns after decussating in the anterior commissure with corresponding fibres from the opposite side. A large number diverge equally *downwards* and *upwards* for some distance in the gray substance, while the remainder pass more deeply backwards and are lost. In no single instance has Mr. Clarke seen any portion of these roots, take a longitudinal course, on directly entering the anterior white columns.

But besides the transverse bundles which form the anterior roots, a continuous system of exceedingly fine transverse fibres may be seen to issue from the anterior gray substance. They pass through, nearly all, at right angles to, the anterior white columns, and disappear as they proceed towards the surface of the cord; but as many of them may be observed to turn round and take a longitudinal direction, it is probable that at the points where they disappear, they all follow the same course. Within the gray substance they wind about and are gradually lost, mingling with the fibres of the anterior roots, and with those proceeding from the fine bundles of the posterior roots, which perhaps are continuous with them.

It may then, according to Mr. J. Lockhart Clarke, be fairly laid down as a well-established fact, that nearly all, if not the whole of the fibres composing the roots of the spinal nerves, after passing through the anterior and posterior white columns of the cord, proceed at once to its gray substance: and that if any of them ascend *directly* to the brain, it must be *those only* of the *posterior* roots which run longitudinally in the posterior columns.

Professor J. L. C. Schroeder Van Der Kolk, in the year 1847, detected a close connection between the peripheric distribution of the sensitive and motor nerves, by the discovery of the law of the course and distribution of sensitive nerves in the skin, namely, that throughout the body the sensitive branches of a mixed nerve run to the part of the skin, which is moved by the muscles receiving motor filaments from the same nerve-trunk, so that, the action of the muscles being known, we can according to this law, even *à priori*, define the distribution of the sensitive nerves in the skin.

This law may be announced thus: *While the nerve gives off motor branches to the muscles, its sensitive branches run to the part of the skin which is moved by the same muscles, or, in other words, a spinal nerve gives its motor branches to the muscles as instruments of motion, and its sensitive branches to the part moved.*

Several phenomena led this accurate observer and distinguished physiologist, to suspect that a closer central connection, must exist between the sensitive and motor nerves of the same trunk; and for these reasons, he endeavored to ascertain whether a more accurate investigation of the structure of the spinal cord would enable him to trace out this connection, and elucidate most questions as to the structure and functions of the spinal cord, especially, as the numerous vivisections which had been performed, had led rather to greater perplexity than to the establishment of fixed truths. Schroeder Van der Kolk, communicated the results of his investigations first provisionally in the Reports of the transactions of the section for Physical and Medical Science of the Provincial Society of Utrecht, on the 26th of June, 1848, and subsequently brought them more in detail, and illustrated by various preparations, in the autumn of the same year, before the Royal Netherland Institute. Professor Schroeder Van Der Kolk, continued the investigations on the minute structure of the spinal cord, and laid their results before the Dutch Academy of Sciences on the 24th of December, 1853: the communication was, however, not read until the subsequent meeting on the 27th of January, 1854, and was printed in the second volume of the “Transactions of the Academy.” In presenting the matured views of Professor Schroeder Van der Kolk, I shall quote from the valuable translation of the works of this anatomist and physiologist, “on the Minute Structure and *Functions of the Spinal Cord and Medulla Oblongata*,” by William Daniel Moore, published by the New Sydenham Society 1859, and which must not be considered as a mere translation of the Essays, originally published by the Royal Academy of Sciences, at Amsterdam, in 1854 and 1858, but on account of the large amount of additional matter and alterations furnished the translator by the distinguished author, should be regarded as a second and revised edition of the original works.

The following conclusions were drawn by Professor Schroeder Van der Kolk, from his investigations on the anatomical structure of the spinal cord.

1. The ganglionic cells, especially in the anterior horn, are connected with one another by more or less ramified fibres of communication, and thus form more or less distinct groups.

2. From the ganglionic cells, especially in the middle and anterior parts of the anterior horn, arise the motor nerves, which unite at the margin of the gray matter into one, or commonly two or more nerve-roots close to one another, and now leave the spinal cord in a transverse direction in order to compose the roots of the motor nerves.

3. Along the outer edge of the anterior horn run marginal fibres or filaments, which take their origin from the rays dividing among the longitudinal columns, and are connected with the ganglionic cells, situated in great number along the outer edge of the anterior horn. These cells are again connected with others more deeply placed, and so eventually with the group of ganglionic cells, whence the motor nerve arises.

4. The anterior longitudinal columns consist of white, mostly parallel, medullary fibres which pass into the transverse rays just mentioned, and so convey the orders of the will to the ganglionic cells in the gray matter; the longitudinal fibres, which are situated next the gray horn, curve directly, in order to pass into a ganglionic cell.

5. The posterior nerve-roots contain two sorts of filaments, those for proper sensation and those for reflex action. Hence the posterior nerve-roots are also much thicker than the anterior.

6. The nerve-roots for sensation pass, immediately after their entrance into the spinal cord, upwards along the posterior columns, in order to repair to the brain, or the seat of perception. They do not penetrate the gray matter. It is, however, not improbable that the sensitive nerves are lost towards the posterior horns in the gray matter in ganglionic cells; whence fibres arise, which cross through the posterior commissures, and on the opposite side as posterior rays, repair in the medulla oblongata upwards as sensitive filaments to the brain.

7. The other filaments for reflex action, pass across towards the posterior horn, and among the longitudinal fibres or columns form several plexuses; in part they press through the scattered gelatinous substance of the posterior horn, to the middle of the gray matter, where they appear to pass into ganglionic groups; perhaps they also give some filaments to the marginal fibres, which everywhere as a band surround the gray posterior horn. The reflex filaments are in this case at least in part, the ascending fibres which at different heights again repair through the posterior horns to the ganglionic cells of the anterior horns.

8. These marginal fibres arise in great part from the nerve rays, which from the posterior horn spread in the medulla; they surround the horn, and at its basis curve from either side towards the centre of the group of ganglionic cells, in which also the reflex nerves terminate. Among these marginal fibres, several, for the most part oblong, ganglionic cells are scattered; some ganglionic cells are met with also in the gelatinous substance, especially nearer to the centre.

9. The posterior horns of the gray matter consist chiefly of very fine longitudinal fibres. Now, as the former in the cervical and lumbar bulbs are at least five or six times thicker than in the dorsal portion of the spinal cord, it follows that the latter are in these parts present in much greater number; whence it would appear that they do not run through the whole spinal cord, but for the most part terminate in the cervical and lumbar expansions, where the majority of reflex actions and movements are excited and combined; they appear, therefore, through their longitudinal direction, more or less to unite several groups of cells, placed above one another, and thus to form longitudinal filaments of communication.

10. The posterior commissure, consisting of white fibres, passes in part into adjoining ganglionic cells, partly into the cells which are present in the centre of the gray matter, while again some fibres are connected with the marginal fibres around the posterior horn

11. The anterior commissure forms a decussation; its fibres push forward in order in part to terminate directly as rays among the inner and anterior longitudinal columns; in part they proceed towards the inner edge of the anterior horn, when they pass into the marginal fibres, which take, as we have above seen, their origin from the rays.

12. The fibres of both the anterior and posterior commissures are not directly connected with the nerve roots, though they are probably connected with the anterior ones by means of the uniting filaments from the several ganglionic groups, and both commissures consist of white fibres.

13. In the spinal cord a central canal may always be found, lined internally with epithelial cells, and sometimes appearing to contain an albuminous fluid; in man it seems to be narrower than in most animals.

The principal points in the physiological inferences, with reference to the spinal cord, may be collated in the following propositions:

1. The several primitive fibres, which are lost as a motor nerve in a muscle or system of muscles, appear to arise from a group of mutually connected ganglionic cells; they receive the impression of our will along the anterior white columns and the transverse fibres or rays connected therewith, passing into such a group; which stimulation, being uniformly distributed over all the cells of the group, produces in all the motor filaments of the nerve arising from it an uniform and simultaneous action.

2. The number of these anterior conducting filaments of volition must thus be proportionate to the number of groups of cells, and the several combinations of which they are capable, and must therefore be much less than the number of medullary filaments for the sensitive nerves in the posterior columns; so that, by the constant accession of new sensitive nerves, the white medullary matter increases more in thickness upwards posteriorly than anteriorly, as is confirmed by the form of the spinal cord in transverse sections.

3. Where numerous muscular nerves spring from the spinal cord, as for the extremities, more numerous groups of cells, whence they arise, must be present; hence it is, that the anterior gray horns in the lumbar and cervical bulbs are so much thicker than in the dorsal region, or the more highly situated portion of the cervical region.

4. In animals whose muscular movements are more simple, as in fish, the spinal cord is slighter. and the gray matter. as well as the ganglionic cells, is much more scanty, as fewer combinations of movements are required.

5. Reflex movements take place. not by over-leaping or transverse connection, but the reflex nerves appear to terminate. partly in a central group of ganglionic nerves, which are more or less directly connected with the small groups of motor cells, and partly seem to pass into the minute longitudinal fibres of the posterior horns. Therefore, as the posterior nerve-roots contain at the same time sensitive and reflex nerves, it is easily explained why they are nearly twice as thick as the anterior roots.

6. The posterior horns of the gray matter. through which. probably, the small groups of ganglionic cells are mutually connected. appear to serve especially for the co-ordination of movements which take place in reflex action: the latter are more general in proportion to the more irritated condition of the gray matter or of the ganglionic cells.

7. Through their connecting filaments the groups of motor cells appear to be so united, that as a stimulus applied to one of the toes is sufficient to excite in a frog, by reflex action, a harmonized movement. or a jump. so, also, perhaps, only one impression is required to produce a co-ordinate movement (for example. a step), which may then again be modified, according to circumstances. by special impressions on each of these groups of cells. The cause of the co-ordination of movements is situated in the spinal cord, and not in the cerebellum.

8. The transverse commissures appear to be designed to preserve the harmony of movements between the two sides: the anterior. which seems to be more connected with the filaments conducting the orders of our will. for the harmony of the voluntary movements, and of the muscles acting simultaneously on each side of the body; the posterior for the involuntary harmony in reflex action. the equilibrium of the body. etc.

9. The two horns of gray matter appear to stand in the closest relation to motion; the anterior are the direct sources of motion. the postesior serve rather for reflex action and co-ordination. After the administration of strychnia. conjestion or effusion of blood takes place in both horns. The latter do not seem to be sensitive.

10. The medulla oblongata appears to be the common central point, where reflex action comes to either side. and on the irritated state of which general spasms, as convulsions and epilepsy seem to depend.

Professor Schroeder Van der Kolk. thus sums up the principal results of his investigations on the structure and functions of the Medulla Oblongata:

OF THE MEDULLA OBLONGATA.

1. In the medulla oblongata, a perfectly unique organization commences. The nuclei, or ganglionic groups. whence the nerves arise. are here more distinct from one another. The nuclei for motion. as those of the hypoglossus, the accessory facial and the small branch of the trigeminus. lie near the raphe or septum: the nucleus of the abducent is still uncertain; the nuclei for the nerves of sensation. which are first distinctly seen in the medulla oblongata, as the portio major trigemini. the vagus. glosso-pharyngeus and auditory. lie more to the outside. and further removed from the raphe. In addition. auxiliary ganglia, or accessory nuclei . each of which has its own function. occur in the medulla oblongata.

2. Of the spinal cord. only the anterior columns pass. in the corpora pyramidalia, as conductors of the orders of our will for the movement of the extremities upwards towards the brain. The lateral columns of the cord terminate on a level with the vagus. which is intimately connected with and exercises a reflex action on them. Consequently, in hemiplegia, we never have paralysis of the half of the trunk. but only of the face, the tongue and the extremities.

3. At the inferior boundary of the medulla oblongata, and above the termination of the lateral columns just mentioned. a new system of fibres begins in the medulla oblongata, descending from the brain (the thalami. and especially the corpora striata), and here dividing into an infinite number of fine longitudinal bundles, separated by transverse fibres. These longitudinal bundles. at least for the most part. curve to penetrate into the raphe, to decussate there. and so to pass over into the nuclei of the nerves of the opposite side, as conductors of the orders of our will, or for the communication of the impression of sensation to the brain. The accessory ganglia also receive the conducting filaments by which they communicate with the brain. from the same fasciculi.

4. The nerves of the medulla oblongata do not participate in the decussation of the corpora pyramidalia. as they are situated higher up. They themselves do not decussate; but in the manner described in the preceding paragraph, the conductors of the orders of our will decussate here also. as in the corpora pyramidalia. for the movement of the extremities. In the medulla oblongata the decussation is in the situation of the nucleus: for the nerves of the extremities is situated above the nuclei, in the known decussation of the corpora pyra-

midalia; in both parts, therefore, there is perfect correspondence. In like manner filaments arise from the nuclei of the sensitive nerves, which decussate and convey the received impression to parts situated higher up. Now, as sensation appears to decussate, and the nuclei of the sensitive nerves lie on the same side as their termination, these nuclei cannot be the seat of the perception of sensation.

5. Besides this, there exists in the medulla oblongata a system of transverse fibres (*fibræ arcuatæ*), some of which arise externally, surround the medulla, and pass into the raphe, while others, in part, arise internally from the corpora restiforma and the root of the trigeminus, in part from the nuclei of the nerves, and from the corpora olivaria. These transverse fibres seem to unite the two halves most intimately, and to produce a bilateral action so eminently characteristic of most nerves of the medulla oblongata, and such as occurs in no other part of the body, being seen in the bilateral action of the face, the tongue, the voice and respiration.

OF THE NERVES OF THE MEDULLA OBLONGATA.

6. In addition to the above bilateral connexion, the nuclei, particularly of the facial, accessory and hypoglossal nerves, are in part connected from behind near the fourth ventricle, by a transverse commissure, which appears to increase the bilateral action of the nerves.

7. Of all the nerves the auditory has in its central nucleus, the largest ganglionic cells, and in it the connexion of the latter with the nerve filaments, and with one another, is very easily seen. From this central nucleus fibres radiate in the direction of the nucleus of the facial nerve, probably for reflex action of the stapedius muscle and of the tensor tympani, and for the partly involuntary reflex movements in the erection of the ears in animals. This nucleus of the auditory nerve is also closely connected with the sensory root of the trigeminus, and the two nuclei of the auditory, are intimately united by many fibræ arciformes, radiating from this point. The so-called roots of the auditory nerve in the fourth ventricle, do not serve for hearing; but appear to be reflex filaments, which are connected by means of ganglionic cells with the auditory nerve, and in terror caused by an unexpected sound, reflect upon the whole muscular system, and place the body in an attitude of defence.

8. The glosso-pharyngeal nerve has this peculiarity; that it passes through the middle of the great root of the trigeminus, thereby perhaps creating a closer connexion between nerves of taste and sensation.

9. The abducent nerve differs from all other nerves of the medulla oblongata in this, that its root, instead of curving inwards to the raphe, bends outwards. In this way it perforates in an outward direction, the fibres of the facial nerve and a portion of the facial nucleus. It does not as Stilling thinks arise from the latter, but merely perforates it, to pass posteriorly and superiorly to the facial nerve, apparently into a nucleus. This nucleus does not appear to be in close connexion with the raphe; that is, no filaments seem to run from the nucleus to the decussation. Perhaps it is more or less intimately united with the higher situated cerebral fibres, passing to the opposite nucleus of the oculo-motor, an arrangement which would afford a simple explanation of the antagonism between the oculo-motor of the one side, and the internus of the opposite side.

10. The nervus trigeminus is one of the most remarkable nerves of the medulla oblongata. While its minor portion, as a muscular nerve, finds its nucleus very near the raphe, the major portion perforates, in an obliquely descending direction, the whole medulla oblongata, to the inferior border of the corpora olivaria. In this course it passes all the other nerves of the medulla oblongata and their nuclei, and gives off fibres to every nerve, except the abducent; consequently, it is connected with, and can act on all the other nerves and their nuclei, as the facial and glosso-pharyngeal, and it is particularly intimately connected with the vagus and accessory, and also with the hypoglossal nerves. In the same manner it is closely connected with the corpora olivaria. Hence the nervus trigeminus is a reflex nerve *par excellence*, whose reflex filaments convey the impression they have received either directly to these different nerve-nuclei, or indirectly give it up again to the auxiliary ganglia.

11. In every situation, where reflex filaments proceed from the roots of the trigeminus to the nerve-nuclei, fresh groups of ganglionic cells arise in this root. It is even probable, that in general, when a nerve filament determines a special action, the latter is communicated to it through ganglionic cells.

ON THE AUXILIARY GANGLIA.

12. Several nerves of the medulla oblongata have their auxiliary or accessory ganglia, which endow them with peculiar and most complicated functions. The principal of these auxiliary ganglia are the corpora olivaria.

13. Almost all these auxiliary ganglia act bilaterally, and are at the same time connected by special radiating fibres with the nuclei of the nerves on which they act.

14. The corpora olivaria, as the largest and most important of the accessory ganglia, are distinguished from other ganglionic groups by their peculiar structure and very small multi-

polar ganglionic cells, whence fibres pass outwards and inwards, to unite as marginal fibres, and fasciculi of different degrees of strength. Of these fasciculi, some run to the central nuclei of the nerves, and others to the raphe, to unite with the corpus olivare of the opposite side. Besides these, there are appendages, or accessory corpora olivaria, which appear to agree with the former in structure and function.

The corpora olivaria are more intimately and closely connected with the nuclei of the hypoglossus, than with the nucleus of any other nerve. This connection is accomplished by a special tract passing out from the hilus of the corpus olivare, and terminating in the nucleus of the hypoglossus. The corpora olivaria are also united by other fibres with the nuclei of the accessory nerve. Besides these connexions, the upper part of the corpus olivare is further united with the nucleus of the facial nerve.

Through these connexions, the corpus olivare seems to serve as an auxiliary ganglion to the hypoglossal and accessory nerves, for the purpose of regulating the innumerable combinations of movements of the tongue, which, as appears from pathological observations, take place in the articulation of the voice during speech, and in deglutition. All these movements require a bi-lateral action, which appears to be effected through the corpora olivaria. It would appear that different parts of the corpora olivaria exercise different functions, according to the nerves with whose nuclei they are connected by radiating fibres, for these several functions, as expression, articulation of the voice, and swallowing, may be separately lost in disease.

Besides these corpora olivaria, another group of larger ganglionic cells occurs also in man and animals as auxiliary ganglia on a level with the facial nerve, being very closely connected on the one side with the nucleus of the facial nerve, and on the other with the root of the trigeminus. This group appears to serve for the reflex action of the trigeminus, in winking of the eyelids, which, as is well known, depends especially on irritation of the fifth pair.

4. The connexion of the nervus vagus and its nucleus with a bundle of longitudinal fibres, which is situated in the outside, and appears to constitute the upper part or summit of the lateral columns of the spinal cord, is of great importance. From the nervus vagus fibres pass into this longitudinal fasciculus, where again ganglionic cells are situated at the seat of transition. This connection appears to be subservient to respiration. Hence it follows, that a very strong centripetal acting stimulus on the vagus, brings all the muscles of the chest and abdomen into a state of tension. The not so strong seems to act, in the first place, by means of these longitudinal fasciculi on the phrenic nerve and the muscles of inspiration, causing the descent of the diaphragm and the enlargement of the chest. As the lateral columns act on the muscles of the trunk, these irritations of the vagus are not followed by convulsions in the extremities, but rather with a hemiplegic paralysis of one half of the trunk.

Both longitudinal columns are connected with one another, as well posteriorly at the fourth ventricle, as anteriorly, by transverse fibres or commissures and fibræ arciformes through the raphe, rendering respiration bi-lateral. A puncture or wound in the middle line of the [illegible] destroys this connexion of action, respiration ceases, and death is instantaneous.

5. Besides these there are also stronger marginal fibres which run parallel with the continuation of the [illegible] toward the hypoglossal and accessory nuclei, and in the same manner [illegible] and then curve inwards. They terminate in the lateral longitudinal columns with which they appear to be connected by multi-polar ganglionic cells. Through these columns, they will act on the lateral columns of the spinal cord, and so on the respiratory organs.

6. With these longitudinal columns, and especially the nucleus of the vagus, the great root of the trigeminus enters into very intimate connexion, so that in some places they seem to coalesce. This state of things is apparently closely related to the known reflex action of the trigeminus in respiration, exemplified in sneezing, etc.

7. Swallowing, when involuntarily excited, is also a reflex action, which is always accompanied with inspiration, and is very complicated. The exciting stimulus appears to proceed from the second branch of the trigeminus, namely the palatine nerve, for division of the nervus glosso-pharyngeus does not prevent swallowing. But the irritation seems to be conducted to the corpora olivaria in man, and to the corresponding parts in animals, where it is reflected on the hypoglossal and accessory nerves, with which these corpora olivaria are closely connected, and through which the act of deglutition is occasioned by the simultaneous contraction of many muscles by bi-lateral action. Perhaps, also, the small root of the trigeminus, by its [illegible], participates in the act. The nuclei of the glosso-pharyngeal also appear to be united with an auxiliary ganglion similar to that of the facial nerve, which auxiliary ganglion is also closely connected with the trigeminus. Schroeder Van der Kolk affirms that he [illegible] in his article. Professor Schroeder Van der Kolk on the Minute Structure and Functions of the Spinal Cord and Medulla Oblongata. New Sydenham Society, London, [illegible].

According to the view of Schroeder Van der Kolk and Wagner the brain and spinal cord [illegible] that massive accumulations of primitive fibres and multi-polar ganglionic cells [illegible] combinations of primitive fibres do not occur except through the interposition of ganglionic cells; consequently all phenomena of innervation depend on combinations with one another, and with central and peripheric nerve paths, of individual ganglionic cells and larger aggregates of the same, as special seats of innervation of various physiological importance. For every separate movement, a special group of ganglionic cells must be present, whence all the nerve filaments arise, which go to a muscle or system of muscles, always acting simultaneously. The sensitive roots divide, after their entrance into the spinal cord, into ascending bundles, passing upwards with the longitudinal columns; and into transverse, which dividing into different fasciculi, proceed towards the posterior horn of the gray matter, and after having perforated the latter, appear to be in great part gradually lost in the group of ganglionic cells, situated in the middle of the gray matter between the horns, and in these last has been recognized by Schroeder Van der Kolk reflex nerves. This observer cannot, however, wholly agree with Marshall Hall, who assumes excito-motor nerves, that is, special nerves, said to accomplish the motions caused by reflexion. This, according to the views of the learned professor of the University of Utrecht, being an hypothesis which is based on no certain foundation; as it is sufficient that the roots of the motor nerves receive the stimulus to action from the group of ganglionic cells, whether this be communicated through the will from before, or through the reflex movements from behind. According to this idea, therefore, the groups of ganglionic cells, may be considered as constituting a battery with two poles, or, rather, capable of being charged from two sides; the one pole is connected by means of the lateral rays, with the filaments which conduct the orders of our will, the other pole, by means of different combinations of ganglionic cells, with the reflex nerves, so that a group is capable of receiving both psychical and physical stimuli. As, however, the posterior roots, in this case, contain two kinds of nerves, those for sensation and those for reflex action, it is not surprising that they should be thicker than the anterior roots, as is universally admitted. According to this view, therefore, reflexion takes place, not by springing over, or transverse conduction, but along fixed routes, whereby the reflex action is regulated. Wagner differs from this opinion in assuming the existence of sensitive fibres passing transversely in the posterior horns into ganglionic cells. There appears to be little probability in this idea, as it is impossible to discover any difference in these posterior transverse roots, and as they perfectly resemble one another, it would naturally follow that they must all be classed either among reflex or among sensitive nerves. The existence among them of two so different kinds of nerve filaments as those for sensation and for reflex action, can hardly be admitted; and the connection of proper sensitive fibres with the posterior horns, may be doubted, because irritation of the gray matter in the spinal cord by strychnia, which gives rise to great congestion in the posterior horns, excites no pain. Lastly, it has been shown that the ascending gray fibres in the posterior horns, at least for by far the greater part, do not run through to the brain, as the posterior horns become so slight in the middle of the back, that most of the ascending fibres have in this situation disappeared. However it must be admitted that the question is still wholly undecided, whether, when reflex sensation or sympathetic sensation takes place, the proper sensitive filaments first communicate their action to one another in the seat of perception in the medulla oblongata, by means of ganglionic cells, as appears to be the most probable supposition, or whether they stand in more intimate connexion with the posterior gray horns and the spinal cord. The assumption appears to be more probable, that the transverse rays which spread from the posterior horns into the posterior white columns, are capable of accomplishing some closer connection between these parts, although, on account of the insensitive nature of reflex action, this is not entirely clear; perhaps they give the knowledge of reflex action. The very large number of slender ascending fibres in the posterior horns does not appear to render this explanation of the phenomena of reflex action improbable. It must be remembered that in a somewhat irritated condition of the spinal cord every sensitive point of the skin conveys its stimulus to all parts of the cord, and for this an infinite number of fibres is required adequately to produce a proportionate connexion with the several ganglionic cells. Wagner, with Schroeder Van der Kolk, admits, by the same reasoning, the presence of reflex fibres in the posterior roots, whereby the thickness of the latter is increased, and he therefore also admits the reflex motor nerves of Marshall Hall. Wagner puts it forward as doubtful, whether the fibres conveying voluntary stimulation to the muscles, and arising from the brain, unite with a peculiar system of ganglionic cells in the spinal cord and medulla oblongata, or whether the ganglionic cells, with the reflex motor fibres, serve this purpose, of which he holds the latter opinion to be the more probable, inasmuch as the will can suppress the reflex phenomena. By the discovery of the connexion of the transverse fibres radiating from the anterior horns, with the longitudinal anterior columns, Schroeder Van der Kolk anatomically decided this question. Most probably the longitudinal slender fibres of the posterior horns consist of filaments of communication, connecting the several groups of ganglionic cells with each other; and in this manner the difficult theory of reflex action is simplified, as the reflex nerves pass between these longitudinal filaments, perhaps partly pass into them, and the latter are probably connected with the same ganglionic groups in which the reflex nerves terminate; for otherwise, as has been already observed, it is difficult to understand how the posterior horns should be so much slighter and smaller in the dorsal than in the lumbar region, and contain fewer longitudinal fibres, which applies also to the enlarged cervical tract and higher part of the neck. By reflex action the muscles are now first brought into motion, the nerves of which arise nearest to the reflex nerves, where, therefore, the excitation of the reflex nerve, or of some of its filaments, has the shortest way to run from the posterior horn and the centre of the gray matter to the motor cells of the anterior root, both the anterior and posterior roots uniting to form a mixed nerve.

To illustrate his theory of reflex action Schroeder Van der Kolk, supposes the following illustration. Let us suppose a simple case; for example, that a person unexpectedly burns his finger; so soon as he perceives it he will draw his hand quickly back; this is not altogether voluntary; he would do the same, if in an unconscious state, for example, when under the influence of chloroform, or even in sleep. Now what takes place in this case? The forearm is flexed, and at the same time the humerus is drawn back, that is, the biceps and branchialis anticus enter into action for the first, the latissimus dorsi and teres major for the second movement. But there is now no difficulty in supposing that the reflex nerves, which are given off with the sensitive nerves of the finger, through their combination in the spinal cord, irritate the group of ganglionic cells whence the nerves are derived which excite the biceps and branchialis anticus, and at the same time the group of cells, from which the nerves for the latissimus dorsi and teres major arise. Thus through a combination of connecting filaments by means of ganglionic cells, wherein the reflex nerves terminate, both groups are simultaneously stimulated, and so both movements are combined. If the irritation is severe, or if the spinal cord be more than ordinarily sensitive, the stimulus may bring several muscles into action; for example, when a decapitated frog takes a jump on the application of a stimulus to the hind foot or toe, several groups of ganglionic cells are brought into action through the reflex nerves, which groups are more or less connected with one another, and the movement becomes a combined or harmonized one, a jump. Here it must be borne in mind, that a certain amount of irritation is necessary before reflex motion takes place; that is, the cells, wherein the reflex nerves appear to terminate, must be excited to a certain extent before they communicate the action which has been developed to the neighboring group of cells, whence the muscular movement is immediately accomplished; they are like Leyden jars which must be charged before the spark passes. Remote or higher situated reflex cells, which probably are connected by means of longitudinal filaments of communication in the posterior horns with those which are directly stimulated, shall therefore, not be so rapidly excited to action, or to keep to the simile, become charged, as those which receive the stimulus directly from the reflex nerves; and hence it is that almost always, as Volkmann remarks, the next adjoining muscles are the first to be moved. But if the whole spinal cord be in a more highly irritated condition, and if the reflex cells be, as it were more highly charged, only a slight stimulus is necessary to produce a universal discharge, and more general reflex movements take place, as in convulsions, epilepsy, or after the administration of strychnia. This excitation occurs almost always in consequence of a greater determination of blood (congestion,) or as a result of the blood being poisoned, for example, by strychnia. Now if strychnia be given to a dog, this drug as is well-known, is taken up into the blood, and the blood so poisoned is in contact with the gray matter of the spinal cord, which is so rich in vessels, and still the convulsions which take place are intermittent. Suddenly, without any previous symptoms, the dog falls, becomes convulsed, or makes involuntary movements; but these cease after some time, and now the animal appears to be perfectly well. In such a case Professor Schroeder Van der Kolk, has seen intervals of even more than an hour, in which he could touch and stroke the dog, while he ran round without any appearance of injury, until the sensibility had again become so great, that even the simple blowing of air upon him excited convulsions. Thus notwithstanding that the gray matter was incessantly in a state of interchange with the poisoned blood, the convulsions were not constant, and it was not until after a tolerably long interval that the susceptibility was sufficiently restored to reproduce them. The same phenomenon is observed in epilepsy: if a severe attack has taken place, the patient is usually free for a long time, if a slight attack ensues, a second often occurs after a short interval; in the latter case only a partial discharge had, as it were, occurred, so that it was not until a second rapidly followed that the equilibrium could be restored. And it is perhaps to this cause that we should attribute the periodicity of so many phenomena which appear to stand in close connexion with the spinal cord, as agues, febris larvata, etc. If the excitability is exalted, as in children, only a slight stimulus is often required to produce general reflex phenomena, that is, convulsions; if a more remote group of ganglionic cells is excited to a higher degree, a remote stimulus through a reflex nerve, distantly connected with this group by means of filaments of communication, will be able to produce reflex movements in it, as is sometimes the case in hysterial affections. According then to the reflex theory as expounded by Schroeder Van der Kolk, the groups of motor cells, which he designates as such for distinction's sake—whence the motor nerves arise, possess as it were two poles, that is they are connected on the one side with the conducting filaments of the will (anterior columns), posteriorly with the reflex nerves by means of other ganglionic cells. Now if these reflex nerves are connected through communicating filaments with several groups of motor cells, so that by reflex action a harmonized movement, for example, a jump, takes place, it may be assumed that by means of the anterior conducting filaments of volition, the groups are most easily brought harmoniously into action, whereby a combined or co-ordinated movement is produced. We have indeed the power of voluntarily moving a separate muscle, for which separate conducting filaments may exist, but we can with equally little exertion or consideration bring into action several groups of muscles, of which a step, a co-ordinated movement is the result, and this is probably produced by a pre-arranged connexion, by means of the communicating filaments of several groups, which are affected as by reflex action. That the production of harmonized movements, for example, taking a step, is referable to the organization and action of the spinal cord, that is to different intimate connexions of certain groups of ganglionic cells, and therefore may be said to be pre-arranged in the structure of the cord, will appear extremely probable, if we watch a very young child, which when the mother takes it up in her lap, very easily begins to make the regular movement of a step, alternately with the right and left foot; and this is seen more clearly in a young chicken, which runs off immediately after leaving the shell. Different combinations of muscular action are necessary for the taking a step, which are not learned by study and practice, ending after many failures in a successful election; but the combination which is required for the purpose must already exist, organized, and, as it were, pre-arranged in the spinal cord, so that a single impress is sufficient to bring this combination into action. Our mind knows neither the muscles or the instruments, nor their number or situation, through whose combined action it produces a step. What study it would require, if out of all the possible irregular muscular movements of which the leg is capable, we were obliged, by practice, to learn to combine those which produce a step. The cause of the co-ordination of muscular movement is therefore situated, as Volkmann correctly supposed, in the spinal cord, and Schroeder Van der Kolk, considers it to be incomprehensible how any one could ever have referred it to the cerebellum; for if the cause of this co-ordination lay in the cerebellum no harmonized reflex movements could take place in a decapitated frog. In the opinion of Schroeder Van der Kolk, the experiments of Flourens, Hertwitch, and others are easily explained; the motor fibres pass from the corpora pyramidalia through the pons varolii to the crura cerebri; they here decussate with the transverse fibres of the pons, and between both lies a thin layer of gray matter, containing small multipolar cells. If a part of the cerebellum be taken away, the violent irritation so produced is reflected by means of the transverse fibres on the corpora pyramidalia and irregular movements are the result. If the cerebellum was the seat of co-ordination, regular movements would of necessity ensue on irritation of that organ. But in ulceration of the cerebellum, when the irritation is more chronic and not so violent, Schroeder Van der Kolk, has never seen irregular movements arise. He thinks therefore, that the difficult phenomena of reflex action may be satisfactorily explained by the theory of special groups of motor cells and of reflex cells, and the varying degrees of connection in which these are placed with one another by means of their communicating filaments. This view also supplies an explanation of Schilling's singular observation, that of the transverse roots of the posterior nerves in the gray matter, some bundles curve upwards but others downwards. Were these sensitive nerves, there could be no possible reason for these curving downwards; whereas if they are reflex nerves, it follows from the nature of the case that some bundles may and even must be in connection with cell groups situated above, and others with cell groups placed beneath them, and consequently they must curve towards the latter.

The commissures, connecting the right and left sides of the spinal cord, appear to participate more or less in the production of the reflex phenomena; and it has in fact been shown that the fibres from the posterior commissures run for by far the greatest part transversely, and in the middle between the two gray horns are lost partly in the same ganglionic groups, in which the reflex filaments also disappear, and seem partly to terminate in the small group of ganglionic cells situated at the side of the central canal: there is, therefore, every probability that the fibres of the posterior commissures serve for lateral reflex action, and are consequently capable of transferring to the opposite side the impression received in the groups of reflex cells, while those of the anterior serve to produce in one voluntary movement harmony and agreement between the two sides, and so to preserve equilibrium. But, as the decussated fibres of the anterior commissure pass either directly as transverse rays into the anterior medullary columns, or by means of the marginal fibres and cells are more directly connected on the inside of the anterior horn and the rays proceeding thence, with these longitudinal columns, which Schroeder Van der Kolk recognizes as conductors of the orders of the will—the will must exercise more influence on the anterior commissure, and by this route must the given impression be conveyed to the other side. We can thus see, not only how the harmony of the movements of both sides is maintained, as has been already observed, but that this arrangement may also influence the muscles, which either always or almost always

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any reason be referred Moreover, it is well known, that injury of the more highly situated parts, especially of the cerebrum, occasions no pain, and the cerebrum is insensible to pain. If from the preceding facts it is laid down, that both horns of gray matter in the spinal cord serve for motion, the anterior for more direct motion, the posterior for reflex action, and coordination, it becomes intelligible why vivisections performed on animals, in which it has been attempted to cut through only the posterior or the anterior columns, have lead to such discordant results. It is indeed, evident that it is absolutely impossible to cut through these columns, without wounding the gray horns, which project across them, the necessary result whereof will be that different movements must be produced by this injury, whether of the anterior or of the posterior horns, according to the different groups of ganglionic cells, reflex nerves, or filaments of communication which are wounded; so that this question can never be solved in this way, and confusion, rather than light and knowledge, will have resulted to physiology from such experiments.

E. Pflüger, from a great number of observations has shown, that reflex action is at first strictly unilateral; furthermore, that if reflex action arises from a stimulus in the brain or cerebral nerves, the reflex movements in their farther progress extend to the nerves situated inferiorly, and thus to the medulla oblongata; that, on the contrary, if reflex action arises from a spinal nerve, it extends in its further progress from below upwards towards the medulla oblongata, and not *vice versa;* but that if the affection has reached the medulla oblongata the reflex movement may again extend in an inverse order to the lower parts, or pass into general convulsions; that lastly, if a reflex movement arises in motor nerves which are very remote from the insertion of the sensitive nerve primarily affected, these remote motor nerves are always such as arise from the medulla oblongata. Hence it appears that the medulla oblongata is the principal centre, whence the more general reflex movements and convulsions take their origin; and Schroeder Van der Kolk has shown, by his masterly investigations, that the medulla oblongata is the starting point from which epileptic fits arise, and to which the attention of the physician should be principally directed; and that though the primary irritation may be remote, for example, in the bowels, a morbidly exalted sensibility and irritation in the medulla oblongata will always exist, rendering it more capable of discharging itself, as it were, in involuntary reflex movements.

The preceding theory of reflex action, as expounded by Schroeder Van der Kolk, and based upon his extended and accurate microscopical, anatomical and physiological researches and investigations, must be accepted as the last and most perfect expression of this doctrine, which, as we have seen, had its origin more especially with Unzer and Prochaska.

Brown-Séquard* concluded, from his numerous experiments, that the posterior columns of the spinal cord, are sensitive, and that they do not conduct directly to the brain; but convey impressions to the gray matter of the cord, which transmits them inwards; that the conductors of sensitive impressions, whatever they may be on their entrance into the cord, for the most part pass downwards and join the gray substance above the point of entrance; and that a still smaller number at once lose themselves in the center of the cord. All these fibres effect their crossing from side to side in the spinal cord, and no crossing of sensitive fibres takes place in the brain or medulla oblongata.

The anterior and lateral columns are motor and centrifugal, their fibres pass directly onwards from the cerebrum, and effect their crossing in the lower part of the medulla oblongata.

The gray matter of the cord receives sensitive impressions from the posterior roots of the nerves, conducts them onwards to the brain, or reflects them to the motor nerves. It is itself insensible to mechanical or galvanic stimulus.

Brown-Sequard supports these propositions by numerous physiological experiments and pathological observations.

We have thus endeavored to present the history of the doctrine of the reflex function of the cerebro-spinal system, and to examine impartially the facts upon which it rests, by means of analysis of the labors of original observers, and whilst striving to render impartial justice, we have at the same time made an effort to aid the student of medicine in his inquiries, by bringing him in contact with the original sources of our knowledge upon this difficult, complex and important subject.

We propose to examine in a similar but briefer manner the results of investigations directed more especially to the determination of the functions of the cerebrum and cerebellum. Much relating to this subject has already been presented in the preceding pages, and we have recorded the views of various writers as [illegible] Willis, Unzer, Prochaska, Sir Charles Bell, Marshall Hall, [illegible] Van der Kolk, [illegible] and others with reference to the functions of the cerebrum and cerebellum in sensation and motion and the reflex function of the spinal cord and [illegible] nerves.

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*Experimental Researches applied to Physiology and Pathology. By E. Brown-Séquard, M. D., etc. New York, 1853.

Sur les Résultats de la Section et de la Galvanisation du Nerf Grand Sympathétique au Cou. Paris, 1854.

Rapports sur quelques Expériences de M. Brown-Séquard. Par M. Paul Broca. Paris, 1855.

Deux mémoires sur la Physiologie de la Möelle Épinière. 1855.

Recherches Expérimentales sur la Transmission Croisée des impressions sensitives dans la Moëlle Épinière. Paris, 1855.

Experimental and Clinical Researches on the Physiology and Pathology of the Spinal Cord and some other parts of the Nervous Centres. Richmond, 1855.

[illegible] DURING RECENT [illegible] TO THE DETERMINATION OF THE FUNCTIONS OF THE CEREBRUM AND CEREBELLUM.

[illegible] the intellectual faculties appear to be exclusively confined to the brain, but as we descend in the scale of vertebrate beings to those whose functions and especially whose nervous functions are less perfect, it would appear that the spinal cord increases with the [illegible] of certain of its activities, and in animals of the simplest organization the brain entirely disappears and the spinal cord seems to be substituted for it. It has been doubted with reason whether the animal without a brain possesses any degree of what can properly be termed perception; and it has been conjectured that the sole object of the nervous system may be to convey impressions from one part to another, which are necessary for the functions of the animal, but which do not excite any sense of consciousness.

As the nervous centres and their grey or vesicular constituents more especially appear to originate the nervous force, and as certain nerves, termed motory and efferent, conduct it to the [illegible] muscular fibre on which it acts by producing contraction, and other nerves termed sensory and afferent carry the impressions received at their distal ends to the centres; it is evident that sensation, or the appreciation of the impression by the individual, follows only when the afferent nerve conveys the impression to the brain. When it stops short in the spinal cord or ends in a ganglion, it may excite a corresponding or connected efferent nerve to produce motion or a reflex action, which may then take place without sensation or volition. In the Lancelet (Amphioxus), which presents the simplest form of vertebrate existence, the nervous axis shows no distinction between brain and spinal cord. It is a slender tract of [illegible] a continuous cord of spinal [illegible] along its middle third, [illegible] along the median line of the upper surface, and tapering to both ends [illegible] the front end being less acute. A streak of pigment [illegible] the middle of the upper surface. [illegible] the origins of the nerves. These [illegible] and appear to come off as simple cords. They perforate the membranous neural canal, and accompany the inter-muscular septa, dividing into two [illegible]—one to the dorsal, the other to the ventral or visceral muscular segments. The first pair of nerves, which Professor Goodsir thinks might correspond to the olfactory, [illegible] above the mouth. The second pair is much larger [illegible] the neural canal, and sends its branches upward and backward toward the [illegible] of the segment, where it communicates with the dorsal branches of several succeeding nerves [illegible] backward, communicating with the corresponding part of the succeeding nerves of its own side, in some way beyond [illegible] the several consecutive pairs of nerves in the [illegible] trigeminal and vagal, [illegible] with the same relations to the [illegible] the Lancelet. The succeeding nerves divide, [illegible] corresponding in number with the muscular segments. This is the most simple permanent condition of the [illegible] sub-kingdom. In all other [illegible] vagal, trigeminal, and spinal sense nerves, [illegible] disposed in a linear series parallel with the [illegible] Anatomy of the Vertebrates, by Richard Owen, [illegible].

[illegible] Professor Richard Owen, the average proportional weight of the brain to the [illegible] performance [illegible] of sense. [illegible] there[illegible] with the general bulk of the body. [illegible] the eyes, which [illegible] active and [illegible] of the medulla [illegible] respiratory nerves.

Professor Owen has recorded the following interesting observations upon the comparative [illegible] —

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[1] The [illegible] gradation of the connection between the extremes of structure presented by the Myxine and the [illegible] With regard to these two views have been taken, [illegible] according to the other it is the seat of the muscular sense,

or the regulator of voluntary motion. Many experiments in which the cerebellum has been mutilated or removed from warm-blooded animals, support the idea of its intimate relation with the locomotive powers. But to the conclusions from these experiments, has been objected the possibility of the convulsive muscular phenomena having arisen from the stimulus of the remaining centres, occasioned by the mutilation or destruction of the one in question; and it may well be doubted whether nature ever answers so truly when put to the torture, as she does when speaking voluntarily through her own experiments, if we may *so* call the ablation and addition of parts which comparative anatomy offers to our contemplation.

If in reference to the sexual hypothesis of the cerebellum, we contrast the Lamprey with the Shark, we shall be led by the much larger proportional size of the generative organs in the lower cartilaginous fish, and from the observed fact of the male and female Lampreys, entwining or wreathing themselves entirely about each other, mutually aiding in the expulsion of their respective generative products, and so absorbed in the passion as to permit themselves to be taken out of the water and replaced there, without interruption of the act, to expect a larger cerebellum in the Lamprey than in the Shark. But the very reverse of this is the fact: the Lamprey has the smallest, and the Shark the largest, cerebellum in the class of fishes. If on the other hand, we compare the Cyclostome and Plagiostome Cartilaginous fishes, in reference to their modes and powers of locomotion, we shall find a contrast which directly accords with that in their cerebellar development. The Myxine commonly passes its life as the internal parasite of some higher organized fish; the Lamprey adheres by its suctorial mouth to a stone, and seldom moves far from its place; neither fish possesses pectoral or ventral fins. The Shark on the contrary, unaided by an air bladder, sustains itself at the surface of the sea, by vigorous muscular exertion of well developed pectoral and caudal fins, soars, as it were, in the upper regions of its atmosphere, is proverbial for the rapidity of its course, and subsists like the Eagle, by pursuing and devouring a living prey; it is the fish in which the instruments of voluntary motion are best developed, and in which the cerebellum presents its largest size and most complete structure. And this structure cannot be the mere concomitant of a general advance of the organization to a higher type for the sluggish Rays, that grovel at the bottom, though they copulate, and have in most other respects the same grade and type of structure as the more active Squaloid Plagiostomes, yet have a much smaller cerebellum, with a mere crucial indentation instead of transverse laminæ. A more decisive instance of the relation of the cerebellum to the power of locomotion is given by the Lepidosiren in which with a more marked general advance of organization than in the Ray or Shark, the cerebellum has not risen above the simple commissural condition which it presents in the Lamprey; the generative system, however, of the Lepidosiren is as complex as in the Plagiostomes, and is more extensive; but the fins are reduced to mere filaments, and the fish is known to pass half the year in a state of torpid inactivity. The cerebellum is large in the Chimæra. In the heavy laden ganoid fishes, the cerebellum is smaller than in the ordinary osseous fishes; the imbricated armour of dense enamelled bony scales must limit the lateral inflections of the tail; so we find in Polypterus the cerebellum hardly more developed than in Lepidosiren, whilst in the somewhat more active and predaceous Lepidosteus it is the smallest of all the segments of the brain. In the grovelling Sturgeons the cerebellum offers a grade of development above that in the Lepidosiren. Finally, amongst the normal osseous fishes, the largest and highest organized cerebellum has been found in the Tunny, whose muscular system approaches, in some of its physical characters, most nearly that of the warm-blooded class.

If we could enter the sensorium of the fish and experience the kind of sensations and ideas derived from the inlet of their peculiarly developed and enormous eyes, we might be enabled to understand the office of the peculiar complexities of their large optic lobes; without much experience, we can at best only indulge in vague conjecture from the analogy of our own sensations. We find, when nature reduces the organs of sight to such minute specks and can give but a feeble idea of the presence of light, sufficient perhaps, to warn the Amblyopsis to retreat to the darker recesses of the subterranean abode, that the optic lobes are not reduced in the same proportion, but retain a form and size, which as compared with their homologies in other animals, are sufficiently remarkable to suggest a function over and above that of receiving the impressions of visual spectra, and forming the ideas consequent thereon.

The anatomical condition of the prosencephalon, and its homology with the hemispheres of the bird's brain experimented on by Flourens, would lead to the belief that it was in this division of the fish's brain that impressions become sensations, and that here was the seat of distinct and tenable ideas; of such for example as teach the fish its safest lurking-places, and give it that degree of caution and discernment which requires the skill of the practiced angler to overmatch. If different parts of the prosencephalon were special seats or organs of different psychical phenomena, such phenomena are sufficiently diversified in the class of fishes, and are so energetically and exclusively manifested as to justify the expectation on that physiological hypothesis of corresponding modifications in the form and development of the homologues of the cerebral hemispheres. Some species, as for example the Shark and the Pike are predatory and ferocious; some, as the Angler and the Skate, are crafty; some, as the Sword-fish and Stickleback, are combative; some, as the Carp and Barbel, are peaceful, timid browsers; many fishes are social, especially at the season of oviposition; a few are monogamus and copulative; still fewer, nidificate and incubate their ova.

Now, if we compare the prosencephala of the Shark and Pike, fishes equally sanguinary and insatiable, alike unsociable, the tyrants respectfully of the sea and lake, we find that these parts of the brain differ more in shape, in relative size, and in structure, than in any two fishes. The prosencephalon of the Pike, is less than the cerebellum, much less than the optic lobes; in the Shark, it exceeds in size all the rest of the brain; in the Pike the prosencephalon consists of two distinct lobes brought into communication only by a slender transverse commissure; in the Shark, the hemispheres are indistinguishably blended into one large sub-globular mass. If we compare the prosencephala of the Pike with those of the Carp, we find them narrow in the devourer, broad in the prey.

The Lophius lurks at the bottom, hidden in the sand, waiting like the Skate for its prey to come within reach of its jaws; the difference in the shape, size and structure of their prosencephala, is hardly less than between the Shark and the Pike. The combative Stickleback has longer and narrower prosencephala than the cowardly Gudgeon. The nidificative and philo-progenitive *Callichthys* has neither the antero-laterai, nor the posterior regions of the cerebellum more developed than in the bony fishes generally." Anatomy of Vertebrates—London, 1866, Vol. 1 pp. 289–290.

In the Brain of the Crocodile a marked advance is seen in the relative size of the cerebral lobes, especially in regard to their breadth and height posteriorly, giving a pyriform shape to the prosencephalon; the optic lobes, also, are not inferior in bulk to the cerebellum.

The brain of the Bird differs from that of the reptile in the superior size of the cerebrum and cerebellum, together with the folding of the latter, which relates probably to the higher locomotive powers of the bird; it differs from the brain of the Mammal in the absence or small beginning of the fornix, and of the lateral lobes of the cerebellum; it differs from the brain of every other class in the lateral and inferior position of the optic lobes.

In mammalia, the brain has a cerebellum, with large lateral lobes, and the gray superfices much folded; the commissural fibres form, as they cross the under surface of the brain, a defined track or prominence, called pons varolii; the optic lobes are medial in position, and divided by a transverse furrow; the cerebral lobes, are not only united by a round commissure, but by a "lyra" and hypocampal commissure, from which is developed in the majority of the class, a "corpus callosum," or great commissure. In the lowest types of mammals the cerebral hemispheres are without folds, and leave the cerebellum, olfactory lobes, and part of the optic lobes exposed. In man the brain presents an ascension step in development, higher and more strongly marked than that by which the various lower classes are distinguished from each other. Although in the highest mammalia, the cerebrum may extend over the cerebellum, in man not only do the cerebral hemispheres overlap the olfactory lobes and cerebellum, but they extend in advance of the one, and further back than the other; and their posterior development is so marked that anatomists have assigned to that part the character of a third lobe; it is peculiar, with its proportionally developed posterior ventricular horn and "hippocampus" minor, to the genus *Homo*. Concomitantly with the correspondingly developed anterior lobes of the cerebrum, the ventricle is in like manner produced, into a horn-like form, in advance of the corpus striatum. The superficial gray matter of the cerebrum through the number and depth of the convolutions, attains its maximum extent in man. Peculiar mental powers are associated with this highest form of brain; and their consequence strikingly illustrate the value of the cerebral character, and sustain the position that the *Genus Homo*, is not merely a representative of a distinct order, but of a distinct subclass of the mammalia. While the human brain is exceeded in weight by that of the Elephant and Whale, it is absolutely heavier than in all other animals; on the other hand, in the proportionate size of the cerebrum to the cerebellum, the human brain surpasses that of all mammalia, being as 8 to 1.

In proportion as intelligence advances, the surface of the cerebral hemispheres become more extensive and are thrown into more numerous convolutions, separated by deep sulci; thus indicating that there is a relationship not merely between the bulk of the brain and the intellectual faculties, but also with the amount and distribution of the ganglionic cells of the gray matter.

Professor Tiedemann, in his work on the Anatomy of the Fœtal Brain, has discussed the question, whether, according to the common opinion, the spinal cord be a production of the brain; or whether, according to the doctrine which has been supported by Gall, the brain should not rather be considered as an appendage to the cord, and as a production of it. He conceived that he had clearly proved this last to be the correct view of the subject, resting his opinion principally upon the progressive development of the parts. With respect to the progressive formation of the cerebrum, by tracing its development in the fœtus, and comparing this with its structure in the different classes of animals, Professor Tiedemann has shown that as we advance from the fœtal to the more perfect state of the brain in the human subject, or from the inferior animals to those that possess a more complete organization of the nervous system, the cerebral lobes become gradually more elevated and arched, and that their convolutions and sinuosities are progressively developed, so as to give, in man, its elliptical and almost globular form. It is thus shown by Embryology, as well as by Comparative Anatomy, that the human brain is distinguished from that of all animals, both by the size and elevation of the hemispheres, and by the greater number of convolutions.

The vast superiority of man over all other animals, in the faculties of the mind, which may be considered as a generic distinction of the human subject, led physiologists at a very early period to seek for some corresponding difference in the brains of man and animals. They naturally investigated the subject in the first instance, by comparing the proportion, which the mass of the brain bears to the whole body; and the result of this comparison, in the more common and domestic animals, was so satisfactory that they prosecuted the inquiry no further, but laid down the general proposition, which had been universally received since the time of *Aristotle*, that man has the largest brain in proportion to his body. Some more modern physiologists, however, in following up this comparative view in a greater number of animals, discovered several exceptions to the general position. They found that the proportion of the brain in some birds exceeds that of man; and that small mammalia (some quadrumana, and some animals of the mouse kind) equal the human subject in this respect. As these latter observations entirely overturned the conclusion, which had been before generally admitted, Sömmering furnished another point of comparison, viz: That of the ratio which the mass of the brain bears to the nerves arising from it.

The fact has been long known, that when the spinal cord is compressed or divided in any part, the limbs that are supplied with nerves which branch off below the injury are paralyzed; and the nearer to the head the injury is situated, so much more extensive is the derangement of the different functions; and there are cases upon record, where, after dislocation or fracture of some of the cervical vertebratæ, all power has been lost over the voluntary muscles, and the functions of the abdominal and thoracic viscera, have been nearly suspended, yet for the time that life was capable of being continued under these circumstances, the cerebral functions and the mental faculties have remained in a sound state. If the brain, therefore be considered as the centre of perception, it follows that an injury to this organ, is attended with a loss of sensation of the whole system, though each of the organs of sense and motion may be individually in a sound state, as has been so often witnessed in the effects of external violence upon the brain, and in various diseased states either of nervous matter itself, or of other bodies in its vicinity, such as tumors of the skull, thickening of its membranes, or effused liquids of any kind pressing upon the surface of the brain, or contained within its cavities. Pressure is undoubtedly, one of the most frequent causes of the loss of nervous power; and this may take place, without any permanent injury to the part compressed, for when the pressure is removed, the organ frequently resumes its ordinary functions.

The question was early raised by physiologists, whether when volition is exercised and muscular contraction is produced, the first effect consists in some change in the brain itself, or whether the will acts immediately upon the muscles? This question cannot be regarded as a merely verbal one, involving more of a metaphysical than a physical inquiry, for analogy as well as the results of direct inquiries into the anatomy and functions of the cerebro-spinal system, strongly favors the opinion, that in volition, some change first takes place in the brain itself, and the results of such change are communicated to the special and spinal nerves and ganglionic centres connected with the organs. Although this view has been generally adopted by modern physiologists and sustained by anatomical research and physiological experiments, a contrary doctrine was maintained by many of the writers of the last century, and especially by the Stahlians, who conceived that the *Soul* is co-existent with the different parts of the body, and is extended through all the organs of sense and the parts subservient to motion. According to Stahl and his disciples, the soul, is immediately concerned in every vital function, and acts directly upon every part of the body. Whilst the opponents of this doctrine, concluded that the brain is the common centre of the nervous system, to which all the impressions of exterior bodies on the extremities of the nerves are referred, and from which originate all actions that are executed by the organs under the control of the will, they were not satisfied with assigning the brain generally as the sensorium commune, but they sought to find out some particular portion, which might be regarded as the more essential organ to which all the rest are subservient. However curious the investigation, and however whimsical the opinions to which it has given rise, and however connected with the discussion, which occupied so much of the attention of the older metaphysicians and physiologists respecting the seat of the soul, or the material organ of perception and volition, the entire enquiry resulted in developing accurate views as to the anatomical structure of the brain, and also led to many important discoveries as to the use of its individual parts. The doctrine was evolved from such discussions coupled with anatomical reșearch and physiological experiments, that not only the various parts of the brain, must each of them exercise some peculiar function, but also, that certain portions of it possess the specific powers of the nervous system in a much greater degree than others.

It would be foreign to our purpose, and perhaps unprofitable, to examine the various notions that have prevailed at different times, such as the supposition, evidently derived from the ancients, that the immediate seat of perception, is not in the brain itself, but in the investing membrane, or the idea of DesCartes, that the *pineal gland*, is the peculiar organ of the nervous function, *and the seat of the soul.*

Those physiologists proceeded upon true inductive principles, who examined the brain after it had been injured by accident or disease, and noted the effects produced upon its faculties by the injury or destruction of special parts. The general results of these inquiries were that the medullary matter in general, possesses the appropriate faculties of the nervous system, in a higher degree than the cortical, and that the sensibility of the medullary part increases as we proceed nearer to the centre of the brain, where was also found a much more elaborate system of organization, and a much greater variety of separate parts, all of which it was fairly concluded serve some appropriate purpose connected with the nervous powers.

An examination of the brain, after it had been injured or diseased, established the remarkable result, that it is capable of undergoing a much greater degree of disorganization, in its mechanical structure, than could previously have been supposed compatible with the maintenance of its functions, without their being materially affected. With respect to the more external portions of the brain, it was well established by the experiments of M. LeGallois, Dr. Philip, and more particularly of M. Flourens, that it may be sliced or cut, or even that large masses of it may be removed without any very considerable effect being produced upon the perceptive faculties. These results corresponded with those pathological observations, in which abscesses have formed in the brain, and tumors and excrescences of various kinds, which when not compressing the remaining parts of the brain, seemed to produce little injury to its functions; and in which different parts of the medulla of the brain have been destroyed by mechanical means. From such facts, Dr. Alison, concluded that it is satisfactorily ascertained that no point of the brain, higher than the corpora quadrigemina nor of the cerebellum is essentially concerned in sensation." Physiol, p. 16.

Anatomists have also attempted to trace up the nerves of the different organs of sense, to particular portions of the brain, which might be considered as their origin. Although many of the nerves may be traced to certain parts of the brain and to the medulla oblongata, no special anatomical centre has been discovered, and the difficulties which were encountered by the physiologists of the last century, were evident from the fact that Soemmering, fixed upon the halitus, or fluid in the ventricles, as the primary seat of sensibility. Such considerations led many physiologists, to conclude that although the brain is to be regarded as the common sensorium, yet this expression can only be employed in a general way, when we speak of the cerebrum and cerebellum, as contrasted with the nerves and spinal cord.

Willis was amongst the first, to distinctly point out certain phenomena sustaining the view, that different portions of the brain are subservient to different offices, as for example, that some are more particularly connected with the organs of sense, some with the voluntary motion, and others with the different vital functions. According to Willis, the cerebrum or proper brain, is the organ of the perception derived from the external senses, and of voluntary motion, while the cerebellum is the source of the involuntary and vital functions; and as we have seen, this opinion was entertained by Boerhaave and others with certain additions and modifications. Although this opinion was partly derived from observations and experiments upon the effects of injuries to the two parts of the cerebral mass respectively, and partly from the disclosures of comparative anatomy, the objections urged by Haller and other physiologists against this hypothesis appeared so weighty, that it was abandoned as untenable.

The French physiologists, have during the present century, been particularly active in the investigation of the functions of the cerebrum and cerebellum, both in the way of direct experiments on living animals, and of pathological observations.

Flourens, especially distinguished himself among the French experimentalists, although in some respects he had been anticipated by the labors of professor Rolando, performed twelve years before. The experiments of the latter, were very similar in the mode of their execution, to those of the former, and in the conclusions deduced from them. The conclusion of Rolando differs from that of Flourens, chiefly in that whereas the latter physiologist, considers the cerebellum to be the regulator, as he he terms it, of the voluntary motions; Rolando regards it as the origin of them, thus more completely separating the primary seat of perception from that of volition.

There is every reason however, to believe that Flourens, was ignorant of the experiments of Rolando, while he was pursuing his investigations, and their coincidence has tended to establish confidence in the accuracy of the results; and they have been also confirmed, in some of their leading points by the subsequent experiments of Serres and Desmoulins, and they moreover obtained to a certain extent the sanction of Cuvier. The observations of M. Flourens, were contained in memoirs read before the Royal Academy of Science during the course of the years 1822 and 1823, (Recherches Expérimentales sur les Propriétés et les Functions du Système dans Animaux Vertébrés). The object of the experiments of Flourens, was to ascertain the properties of the nervous system, and the functions which its different parts respectively exercise in voluntary motion.

The nervous system consists of the nerves, the spinal cord and the brain, and the brain may be considered as made up of the cerebrum, the cerebellum, the corpora quadrigemina, and the medulla oblongata. Flourens conceives that the nervous system possesses three distinct properties; that of volition and perception, which he regards as the same function, and terms sensibility: excitability or the power of directly producing muscular contraction, and coördination: these three functions are exercised respectively by the lobes of the cerebrum, by the nerves of the spinal cord, and by the cerebellum. The method which Flourens adopted to prove his hypothesis, consisted in removing the different parts of the nervous system, or mechanically irritating them, and carefully noticing the effect produced upon the animal; and the chief value of the experiments, consists in the gradual manner in which he proceeded from one part to another, and the corresponding observations which he made upon the state of the animal in each step of the process, by which as least, he was enabled to fix the limit of the seat of the different functions with considerable accuracy. It was thus shown that mechanical injury of the cerebral lobes does not cause pain, or excite muscular contraction, but these effects always ensue from injury of the nerves, the spinal cord, the medulla oblongata and the corpora quadrigemina. The cerebellum agrees with the cerebrum in the absence of pain or muscular contraction, when it is subjected to mechanical injury. The senses of sight and hearing seem to be destroyed by the mutilation or removal of the cerebrum, and a general state of stupor is induced, which renders the animal incapable of voluntary motion. When the cerebellum is mutilated or irritated, a variety of very singular and irregular motions were produced, which did not appear to be properly convulsive, and which seemed to consist in a loss of the power of connecting and regulating the contractions of the muscles, so as to produce the natural and appropriate actions of the animal. The especial result of the removal of the corpora quadrigemina, appears to be the loss of sight; the contractile power of the iris is also destroyed, which it is said still remains after the removal of both the cerebrum and cerebellum. Voluntary motion, or the external senses, except that of sight appear to be necessarily destroyed by the removal of the tubercles. It was well known that an injury of the cerebrum or the cerebellum, is manifested by a loss of the functions of the opposite side of the body; but with respect to the spinal cord, the medulla oblongata and the tubercles, the point was still undecided; the experiments of Flourens, seem to prove that the tubercles act like the cerebrum and cerebellum, while the spine and the medulla oblongata, produce their effect on the same side with that on which they have been injured. One of the most important points which Flourens attempted to establish, was that the lobes of the cerebrum are the exclusive seat of sensation and volition; and yet it is evident from the result of the experiment, that after the removal of these lobes, sensation, although rendered feeble or obtuse, was by no means extinguished, while the functions which depended upon volition, such as the various kinds of locomotion, were still executed by the animal, although it was difficult to excite them into action. The experiments performed upon the cerebellum, whilst leading their author to the conclusion that this portion of the brain, is the organ through which the animal exercises its voluntary power over the muscles, and combines and regulates their actions, so as to produce all the complicated varieties of voluntary motion, may also be equally well explained, without referring them to the action of a distinct or specific nervous function, but rather to the existence of the cerebellum, as a centre of the sympathetic or associated actions of the nerves that are concerned in voluntary motion.

The results of the experiments of Bouillaud, were opposed to those of Flourens, with respect to the functions of the cerebrum, for he found that animals, in whom this part has been entirely removed, still gave evident marks of perception, and performed certain motions, which have been regarded as depending on habit or instinct; he agrees, however, with Flourens, in regard to the functions of the cerebrum. The view of the functions of the cerebrum advanced by Flourens, are confirmed in the main by the experiments of Magendie and Fodéra, whilst the experiments of Desmoulins, which appear to have been equally direct with those of Flourens, were attended with different results.

M. Desmoulins (Anatomie des Systèmes Nerveaux des Animaux à Vertébrés), observes that there are three modes of becoming acquainted with the functions of the nervous system, and assigning to each part of it, its specific office.

The first is that of experiment: by removing successively the several parts of the brain and its appendages, and by observing what effect is produced by these successive removals, we attempt to gain the knowledge of the specific uses, both of the parts that are removed, and of those that are left. The two other modes proceed upon the principles of induction. They consist of duly appreciating the facts which are to be obtained by the study of comparative anatomy and pathology.

Desmoulins remarks, that there are three distinct orders of nervous phenomena; those which produce muscular contraction, that which produces sensation; and those which produce thought. The two first are seated both in the cerebral-spinal system and in the nerves; and in each of these systems every nervous function has its appropriate seat and conductor. The third, which is confined to the cerebro-spinal system, gives rise to a variety of faculties. The phenomena of consciousness, being very different from those of feeling and thought, ought probably to be regarded as a fourth power, and it is further suggested that volition may constitute a fifth distinct nervous function. According to Desmoulins, if we successively remove the whole of the cerebrum, then the optic thalami, and lastly the whole of the cerebellum, so as to leave the insertion of the fifth pair of nerves uninjured, the animal retains the consciousness of all the sensations which have their seat in the face, except those of sight; he is said to manifest the perception of sounds, odours, tastes, and mechanical irritation; he cries out when the organs of the external senses are stimulated; the respiration and the circulation proceed; the muscular motions are no more affected than when the cerebellum alone is removed; and even the power of volition would appear to be not altogether destroyed. But by the division of the spine below the lobe, all the functions are suspended, so as to indicate that this is the place of the gathering and reunion of the sensations of the entire body. And it further appears that the different parts of this lobe have their specific functions; one part being more intimately connected with the sensations of the face, and another with the digestive organs.

With respect to the specific properties of the cerebellum, Desmoulins endeavors to show, that there is no foundation, for the opinion that has been embraced by Gall and others, that the development of this part of the nervous system bears a relation to the generative faculty. Nor does he agree with Rolando and Flourens, that the cerebellum is the great agent in producing or regulating muscular motion. The opinion which Desmoulins entertained with respect to the specific use of this part was, that the mutilation and destruction of the cerebellum "neutralisent une force qui faisait équilibrê avec une autre force produisant la tendance à reculer. Ce n'est donc pas le cervelet lui-même qui est le siége de cette dernière force, il parait l'être au contraire d'une force impulsion en avant, comme nous le verrons plus tard." He quotes certain experiments which were performed by Magendie, and which consisted in dividing one of the pedicles of the cerebellum, the effect of which was a rapid rotatory motion of the animal on its axis, which continues incessantly for a considerable time, and is only prevented by a mechanical obstacle. The conclusion which Desmoulins draws from the experiments of Magendie, is "que deux forces antagonistes circulent par les deux demi-cercles latéraux que forment le cervelet et sa commissure." A no less remarkable effect is stated as being the result of an injury of one of the optic thalami; this, it is said "entraine irresistiblement l'animal dans une course ou dans un vol circulaire ou de manege, sur le côté dont on a blessé le lobe;" and it is also stated that frogs and serpents "tournent sur le côté opposé au lobe blessé."

According to Desmoulins, the volume of the brain is not the measure of the intellect, and the internal contour of the cranium is frequently not parallel to the external surface, so that the relative size of the different parts of these lobes cannot be ascertained by an examination of the skull. There is, however, a mechanical structure which appears to bear a regular ratio to the perfection of the intellectual faculties, viz: the number and character of the convolutions of the hemispheres. Magendie is stated to have been the first to suggest the idea, that there is a connexion between the number of these convolutions and the state of the intellectual faculties. This position is supported by various facts in comparative anatomy, by the comparative state of the fœtal and adult brain in the same kind of animal, as well as by the brains of idiots. Hence is deduced the general principle that the number and perfection of the intellectual faculties, both in a series of species, and in the individuals of the same species, are in proportion to the extent of the cerebral surfaces. With reference to the hypothesis of Gall and Spurzheim, that particular faculties have their seat in particular parts of the brain, whilst admitting that the doctrine is plausible, Desmoulins held that the arguments brought forward by these anatomists were inconclusive, because they were derived only from the external form of the cranium; and he conceived that it is by the examination of the brain, after the partial or total loss of certain faculties, that we are to gain accurate information on this point.

Desmoulins also describes some singular varieties of muscular motions produced by the mutilation or removal of certain parts of the cerebrum. "Se l'on retranche à un mammifère la route de l'hemisphère cerebral et le corps strié; aussitôt l'animal s'élance droit en avant et court sans se dètourner jusqu'à ce qu'il choque un obstacle." This peculiar motion is said to depend upon the destruction of the medullary matter, while the destruction of the cineritious part has no immediate effect upon the motions of the animal, but appears to destroy its volition and intelligence.

Magendie, who, in conjunction with Desmoulins, composed the physiological part of the work to which we have just referred, is entitled to the credit of the various important physiological experiments with which it is illustrated.

In the experiments of Magendie, (Magendie's Journal, t. iii., p. 157), the removal or destruction of the cerebellum produced an irresistible tendency to retrograde motion, and when one of the crura cerebelli was divided, the animal began to rotate with great rapidity, and continued to do so without interruption, as long as it survived the operation. A similar kind of rotation was observed by Serres in a man, in whom, after death a disease of the same part of the brain was detected; and Fodéra also witnessed the same irresistible tendency to retrograde motion after the removal or mutilation of the cerebellum.

Bouillaud, (Magendie's Journal, t. x., p. 36 et seq.), found that the removal of the cerebral lobes of a fowl produced drowsiness and want of perception; but although the intellectual powers were destroyed, the animal still appeared to retain sensation; hence he inferred that these lobes are the more immediate seat of the intellect. He dissented from the conclusion of Foville, that they are "the sole seat of the instincts, intelligence and volition," because some sensations and instincts certainly remain after their removal. He supposes that the different portions of the cerebral lobes possess distinct functions, as some of them may be destroyed, while others continue. Bouillaud details a number of experiments, in which the lobes of various animals, birds, rabbits and dogs were removed, cauterized or laid bare; the general results were that the sensations were not destroyed, but that the intellectual powers were either destroyed or disordered. The removal of the cerebrum destroyed the power of recognizing external objects and intellectual acts depending on this power, but the animal still retained the power of motion and the use of the external senses; the destruction of the anterior part of the cerebrum produced very nearly the same effect with the destruction of the whole. The experiments of Bouillaud were supposed to afford clear proof of the different seats of the sensations and the intellectual faculties; the anterior lobes appearing to be more especially the seat of the intellectual faculties.

The observations of Flourens were confirmed by Hertwig, who found that the cerebellum itself was insensible; that irritation of it excited no convulsions; and that though lesion of it interfered with the combination of movements, the senses of all the other functions were not thereby affected. Hertwig, however, remarked, that if the mutilation of the cerebellum had been partial only, its function was restored. He also found that removal of one side of the cerebellum affected the movements of the opposite side of the body. The experiments of Flourens were also repeated with similar results by Budge and Longet. The comparative effects of removal of the cerebrum and cerebellum, were well shown by Longet, who says: "Take two pigeons, from one remove completely the cerebral lobes, and from the other only half the cerebellum; the next day the first will be firm upon his feet, the second will exhibit the unsteady and uncertain gait of drunkenness."

Longet demonstrated the fact that both sight and hearing are retained after extirpation of the hemispheres, even more clearly than Bouillaud, by the following experiments: The hemispheres were removed from a pigeon, and the animal survived the operation eighteen days; when placed in a dark room, the iris contracted and the eyes winked when a light was suddenly brouht near the eyes, and the bird even followed with its head the motions of a lighted candle. The report of a pistol caused an animal to open the eyes, after the removal of the hemispheres; and it gave other evidences that the sense of hearing was not destroyed by the severe operation. (*Traite de Physiologie*).

The weight of testimony based upon actual experiment, appears therefore to favor the conclusion of Flourens, that the cerebellum possesses the power of co-ordinating the voluntary movements which originate in other parts of the cerebro-spinal centre, whether these movements have reference to locomotion or to other objects. Dr. R. B. Todd, in his elaborate and valuable article on the Physiology of the Nervous System, published originally in the third volume of the Cyclopædia of Anatomy and Physiology, (pp. 720-723), and reproduced in the "*Physiological Anatomy and Physiology of Man*," advocates the view that this power is mental, or dependent for its excitation and exercise. In support of this proposition, he appeals to the experience of our own sensations, and to the fact that the perfection of it requires practice. Thus, he says, that the voluntary movements of a new-born infant, although perfectly controllable by the will, are far from being co-ordinate; they are, on the contrary, remarkable for their vagueness and want of definition. Yet all the parts of the cerebro-spinal centre are well developed, except the cerebellum, and the convolutions of the cerebrum. Now, the power of co-ordination impreves earlier and more rapidly than the intellectual faculties; and we find, according to Dr. Todd, that the cerebellum reaches its development of form and structure at a much earlier period than the hemispheres of the cerebrum. It may also be stated as sustaining this view of the mental nature of the power by which voluntary motions are co-ordinated, that in the first moments of life, provision is made for the perfect performance of all those acts which are of the physical kind. Thus, respiration and deglutition are as perfect in the new-born infant as in the full grown-man; and the excitability of the nervous centres to physical impressions is much greater at the early age, partly perhaps, in consequence of the little interference which is received at that period from the will. That the cerebellum is an organ favorably disposed for regulating and co-ordinating all the voluntary movements of the frame is very apparent, according to Dr. Todd, from anatomical facts. Thus, no other part of the encephalon has such extensive connections with the cerebro-spinal axis; it is connected slightly with the hemispheres of the brain, by the processus cerebelli ad testes, but most extensively with the mesocephali, the medulla oblongata and the spinal cord. Dr. Todd calls especial attention to the fact that its connection with the brain proper is more immediately with that part which may be regarded as the centre of sensation, namely: with the optic thalami. And he suggests, that this connection of the cerebellum with the centre of sensation, may probably have for its object, to bring the muscular sense to bear upon the co-ordination of movements, in which the individual experience of every one shows that, that sense must materially assist. The cerebellum is brought into union with each segment of the great nervous centre upon which all the movements and sensations of the body depend; through the restiform bodies it is connected with the medulla oblongata and the spinal cord; by the fibres of the pons, with the mesocephale, and thus with the anterior pyramids and corpora striata; and through the processus e cerebello ad testes with the optic thalami. With reference to the object of these extensive connections, Dr. Todd affirms that it would be difficult to conceive any function for which so elaborate a provision would be more necessary, than that of regulating and co-ordinating the infinitely complex movements which the muscular system is capable of effecting; more especially, when it seems highly probable that the antero-lateral columns of the cord, and the anterior pyramids and olivary columns supply all the anatomical conditions necessary for the development of acts of sensation and volition.

Whilst therefore, Flouren's views respecting the office of the cerebellum, derive support, both from experiments and anatomy; on the other hand, the evidence furnished by the effects of disease, has not been of that satisfactory and decided character as to convince pathologists of the correctness of the physiological theory. A superficial lesion of either cerebellar hemisphere, or of the median lobe does not cause paralysis, but may produces delirium or convulsions, as a superficial lesion of either cerebral hemisphere may; but a deep seated lesion of the cerebellum involving the central white substance which is continued from the crus cerebelli causes hemiplegia on the opposite side. This similarity between the effects of cerebellar and of cerebral disease, considerably increases the difficulty of obtaining from pathological phenomena any contribution to the solution of physiological questions. Dr. Tood thus explains this similarity:—the transverse fibres of the pons passing through the mesocephale would propagate to this segment the morbid influence of any deep seated lesion of the cerebellum, and thus affect the adjacent pyramid, which again would affect the opposite half of the body just as if the morbid influence originated in the cerebral hemisphere. It is then, this secondary affection of either pyramidal body which obscures the proper signs referable to cerebellar disease.

Some cases of disease of the cerebellum have however been recorded by M. Combette, (*Revue Medicale Avril*, 1831); Magendie and Cruveilhier, (Anat. Physiologique, Liv.. 15, fl. v.) Dr. Todd, (*Cyclopædia of Anatomy and Physiology*, p. 722, S.); Andral, (Clinique Médicale, 1834 tome V.); Guyot, Delamare, Gall (Sur les functions du Cerveau, Paris, 1823, tome III, p. 341); Petiet, (Journal de Physiologie, Paris, 1826, tome VI, p. 162 et seq); Larrey, (*Memoirs on Military Surgery, Baltimore*, 1814; *Observations on Wounds, etc. Injuries, of the Cerebellum, Philadelphia*, 1823, *p.* 199, *et seq*); Wagner and Laborde, (Journal de la Physiologie, Paris, 1861, tome IV, p. 386, p. 637); Fiedler, (Ein Fall von Verkümmerung *des Cerebellum. Zeitschrift für rationale Medicin, Leipzig und Heidelberg*, 1861, *Bd. XI. S.* 250 *et seq*); Vulpian, (Système Nerveux, Paris 1866, p. 629); Bouvier, Hammond, (The Physiology and Pathology of the Cerebellum—Quarterly Journal of Psychological Medicine, New York, 1869, vol. III, p. 237), in which were observed great muscular debility of the extremities, a loitering gait like that of a drunken man, and defective power of coördination.

Professor Austin Flint, Jr., in his recent work on the Nervous System, (New York, 1873), after a careful analysis of the 93 cases of disease of the cerebellum reported by Andral, and of 16 additional cases, collected from various sources by himself, draws the following conclusions:

> "We come now to the main question, whether or not in view of the results of experiments on animals and the phenomena observed in cases of disease or injury of the cerebellum, this nerve centre presides over coördination of action of the muscles, which is certainly necessary to the equilibration, except the muscles of the face and those concerned in speech. This question seems to us to be capable of a definite answer.
>
> Every carefully observed case that we have been able to find, in which there was an uncomplicated disease or injury of the cerebellum, provided the disease or injury involved more than half of the organ, presented great disorder in the general movements, particularly those of progression, * * *
>
> We do not make the reservation that more than half of the cerebellum must be destroyed in order successfully to produce difficulty in muscular coördination, on purely theoretical grounds, but regard this point as positively demonstrated by experiments on animals. These experiments show that one-half of the organ is capable of performing the function of the whole. We have an analogy to this in the action of the kidneys, one of which is sufficient for the elimination of the effete constituents of the urine, after the other has been removed.
>
> Notwithstanding the contrary views of many physiological writers, we are firmly convinced from experiments and a careful study of pathological facts, that there is no one point in the physiology of the nerve-centres more definitely settled than that the cerebellum presides over equilibration and the coördination of the muscular movements, particularly those of progression. In this statement we make exceptions in favor of the movements of respiration deglutition, of the face, and of those concerned in speech, as well as the involuntary movements generally. As another example of a nerve-centre presiding over muscular coördination, we have the instance of the portion of the left anterior lobe of the cerebrum, which coördinates the action of the muscles concerned in speech.
>
> The theory that the disordered movements which follow injury of the cerebellum, is simply due to vertigo is not tenable. In only three of the cases cited, is vertigo mentioned; and in two, the word vertigo seems to be used rather as an explanation of the phenomena observed, than in their simple description. There is a disease involving the semicircular canals, and other parts of the internal ear, called Ménière's disease, in which there is marked want of equilibration and muscular coördination. attended with, and probably dependent upon vertigo. The vertigo is always very distinct, and is mentioned in all the cases; and though it is less in the recumbent position, it is never entirely absent." pp. 386–388.

Foville supposed that the cerebellum is the centre of sensation. This hypothesis has been opposed upon both anatomical and pathological grounds. Thus the cerebellum, wants that general connection, both direct and indirect with *sentient nerves*, which might be inferred if it performed the office in question, not one of the nerves of pure sense having any connection with it; and diseased states of the cerebellum do not give rise to any loss of sensibility, such as might be expected where the centre of sensation is involved.

Gall was the author of the theory that the cerebellum was the central organ of the sexual appetite, and he has been followed in this view by many craniologists or phrenologists. Precise facts, however, have not confirmed, and pathological data seems rather opposed to this view. Baron Larrey was led by his extensive experience to conclude that "the cerebellum exerted a strongly marked vital influence on the genital organs." (*Clinique Chirurgicale*, tome 1, p. 297, 1829); and he cites the following cases to sustain this view:

> "A young soldier of 18, received a blow upon the nape of the neck. He became alarmingly ill in consequence, and only quitted the hospital after three months' sojourn there. Fourteen years afterwards this man presented himself for discharge. He was then pale and beardless, and his voice was piping and feminine. His genital organs were reduced to the size of those of a child of a few months old;—the testes were not larger than haricot beans. He stated that since his accident, he had been without any sexual desire, although he had formerly been like the rest of the comrades in this respect; that his beard, which was well grown at the age of 18, had fallen out. His intellectual faculties had never been affected.
>
> "An artilleryman received a musket shot in the neck, the ball traversing the nape and grazing the occipital protuberances. The sight and hearing were much affected; the testes fell into a sort of atrophy, and the penis shrunk in the same degree, and was altogether inactive." *Clinique Chirurgicale*, tome 1, p. 305.

Gall's view rests on two assumptions; first, that the instinct of generation or of reproduction is *the most indispensable and most powerful of all the instincts;* and secondly that great width of the occipital region of the skull, and thickness of the back of the neck indicate great development of the cerebellum. It is by reason of the assumed transcendent importance of the generative instinct that so large a portion of the brain (an eighth or ninth part of the whole) was assigned by Gall to exercise an exclusive interest over it. The following objections have been urged against the hypothesis of Gall: The sexual instinct cannot be separated from the emotions, and especially from those which are clearly instinctive in their nature; the same part of the brain would probably exercise its influence upon all the emotional actions. But even if the sexual instincts were separable from the other instincts, it seems very questionable whether it is of that paramount importance as to need a separate organ of great magnitude, of complex structure, and of extensive connections with the rest of the cerebro-spinal centre; and if we compare it with the instinct of self-preservation, as manifested either in providing for the wants of the body or for defence against assault, it certainly cannot be admitted to have a superior influence to this the most pressing of all, to which, as far as is known, a separate seat has not been assigned in the brain. Great width of the occipital region, and thickness of the back of the neck, does not necessarily indicate a great development of the cerebellum.

If Gall's doctrine be correct, the great size of the cerebellum in the human subject would warrant the belief that the sexual instinct in man far exceeded that of other animals; but this is by no means the case.

In fish, the sexual instinct appears to be strong, and yet the cerebellum is by no means large; and in the kangaroo, which is described as being most solacious, the cerebellum is one of the smallest to be found in the class Mammalia. The solacity of Monkeys is well known, and yet in them the cerebellum is much smaller than in man, in whom the sexual impulse is much less violent. Against the statement of Gall and most of his followers, that mutilation of the genital organs, or their decay in the advance of age, is attended by marked effects on the cerebellum, may be opposed the results of the researches of M. Leuret, who took the weight of the cerebellum both absolutely, and as compared with that of the cerebrum in ten stallions, twelve mares, and twenty-one geldings, and obtained the remarkable result, that castration tends to *augment, and not to reduce the weight of the cerebellum.*

The few cases quoted by Gall, in which the injury in the neighborhood of the cerebellum seemed to affect sexual instinct have been considered as far from exclusive, for they might equally apply, if it were assumed that the seat of the instincts were in the posterior lobes of the cerebrum, in the medulla oblongata, or in the spinal cord. Burdach has collected the facts which bear upon this question. He has calculated that affection of the sexual passion is observed once in every seventeen cases of lesion of the cerebellum, and once in three hundred and thirty-two cases of lesion of the cerebrum. In apoplectic cases attended with erection of the penis, there has been found effusion of blood in the cerebellum: (Serres, in Magendie's Jour., iii, p. 114). Dunglison observed priapism in a case of inflammation of the cerebellum with serous effusion; but destruction or irritation of the spinal cord in animals also gives rise occasionally to erection of the penis; the coincidence of disease of the spinal cord with affection of the genital organs is much more frequent. Cases have been recorded in which the cerebellum had been injured or destroyed by disease, in which the sexual passion had been strong. The various cases cited by Gall, Larrey, Cruveilhier and others, in which disease of the cerebellum was attended with loss of the sexual appetite, do not really prove any direct connexion betwen the two; although certain facts observed by Budge and Hammond, as well as those cases in which irritation of this part has been followed by persistent erection and manifest exaggeration of the sexual appetite, would seem to imply that the cerebellum may have other functions besides the equilibration and coördination of certain muscular movements. M. Budge (Müller's Archiv., 1839, p. 390), states, as the result of repeated experiments, that irritation of the cerebellum with the point of a knife, in a cat just killed, causes the testicle of the same side to move, so as to place itself more at right angles with the vas deferens. Budge also observed movements in the cornua of the uterus and the Fallopian tubes, in females, following irritation of the cerebellum. (*Lehrbuch der Speciellen Physiologie des Mensohn, Leipzig*, 1862, 788). Hammond (*Physiology and Pathology, of the Cerebellum*; *Quarterly Journal of Psychological Medicine*, New York, 1869, vol. iii, p. 223,) also noted similar movements in cats just killed, and also movements of the intestines and of the muscles of the abdomen, thigh and back.

It must be admitted however, that the physiological and pathological facts, are not sufficiently numerous and definite, to sustain the doctrine of Gall, that the cerebellum in the seat of the sexual instinct.

Physiologists now regard the brain as a collection of ganglia connected by commissures or nerve fibres with each other, and with the different columns of the motor and sensitive nerves. The gray matter of the cerebrum and cerebellum, the olfactory ganglia, the gray matter of the corpora striata, and of the optic thalami, the tubercula quadrigemina and the gray matter of the tuber annulare, or pons varolii, and the ganglion of the medulla oblongata, are generally recognized as distinct ganglia, having separate and distinct functions, which are more or less completely understood.

According to J. Luys, (*Recherches sur le Système Nerveux Cérébro-Spinal sa Structure, ses Fonctions et ses Maladies, Paris*, 1865), the gray matter of the cerebral hemispheres is composed of a mass of mere cells, connected together by their prolongations into a plexus, which in its turn is connected with the fibres of the white substance. From this cortical cellular plexus, white fibres arise, which may be divided according to their direction and destination into two classes. The first class consists of curved commissural fibres, which pass into the white substance to a certain depth and return to the gray matter, connecting thus the gray substance of adjacent convolutions. The second class consists of fibres, which arising from the gray substance of the convolutions, connect them with the corpora striata and optic thalami: these have been called converging fibres, and their general direction, as far as it has been ascertained, is as follows: arising from the internal concave surface of the cortical substance of the cerebrum, at first running side by side with the curved commissural fibres, they separate from the latter as they curve backward to pass again to the cortical substance, and are directed toward the corpora striata and the optic thalami. The limits of the irregular planes of separation of the commissural and the converging fibres contribute to form the boundaries of the ventricles of the brain. The converging fibres arising from all points in the concave surface of the cerebral gray matter, take various directions; those from the anterior region of the cerebrum pass backward, and form distinct fasciculi which converge to the gray substance of the corpora striata; those from the middle portion converge regularly to the middle region of the external portion of the thalami; the fibres from the posterior portion pass from behind forward, and distribute themselves in the posterior portion of the optic thalami; the fibres from the convolutions of the hippocampi and the fascia dentata, are lost in the gray substance lining the internal borders of the optic thalami. In addition to these converging fibres and the curved commissural fibres connecting the different convolutions of each hemisphere with each other, are commissural fibres, which connect the two hemispheres, as well as fibres connecting together the corpora striata and the optic thalami of the two sides. Certain of the fibres converging from the gray substance of the hemispheres to the corpora striata and optic thalami are probably connected with the cells in the gray matter of these parts; other fibres pass through the corpora striata and optic thalami to become finally connected with the fibres of the medulla oblongata, and, through the medulla oblongata, with the columns of the spinal cord; following the antero-lateral columns of the cord from below upward they ascend to the medulla oblongata, decussate in the median line, and from the medulla pass to the brain. Certain of these ascending fibres, which are nearly all continuations of the antero-lateral columns of the cord, ascend to the brain by passing deeply through the pons Varolii; other fibres ascend in the cerebral peduncles, or crura cerebri; and other fibres pass to the tubercula quadrigemina. As the bundles of fibres ascend from the medulla oblongata, they become more and more numerous by reënforcements of fibres, probably derived from the cells of the collections of gray matter in their course.

The marked difference in the appearance of the cells in the most superficial and in the deepest portions of the gray substance; the former being small and presenting a delicate network of anastomosing fibres, resembling the cells of the posterior cornua of the gray substance of the cord: while the latter are large and resemble the so-called motor cells of the cord, has led to the supposition that the larger cells are for the generation of the motor stimulus, while the smaller are for the reception of sensory impressions.

The gray substance of the cerebellum, is divided distinctly into an internal and external layer. The internal layer presents an exceedingly delicate network of fine nerve fibres, in which are found numerous bodies like free nuclei, called by Robin, Myelocytes. The external layer, resembles that of the gray substance of the posterior lobes of the cerebrum, and is divided into two or more secondary layers; the most external portion contains a few small nerve-cells and fine filaments of connective tissue, and the rest of the layer contains a great number of large cells, rounded or ovoid, with two or three, and sometimes, though rarely, four prolongations.

From the gray substance of the convolutions and their prolongations, the fibres of the cerebellum converge to form the crura, or peduncles on each side. The superior peduncles pass forward and upward to the crura cerebri and optic thalami. These connect the cerebrum and cerebellum. Beneath the tubercula quadrigemina, some of these fibres decussate with the corresponding fibres upon the opposite side; so that certain of the fibres of the superior peduncles pass to the corresponding side of the cerebrum, and others pass to the cerebral hemisphere of the opposite side. The middle peduncles arise from the lateral hemispheres of the cerebellum, pass to the pons varolii, where they decussate, connecting together the two sides of the cerebellum. The inferior peduncles pass to the medulla oblongata, and are continuous with the restiform bodies, which, in turn, are continuations chiefly of the posterior columns of the spinal cord. According to Luys, the fibres from the cortical substance of the cerebellum all pass to the corpora dentata and there terminate, being connected with the cells. From the corpora dentata, new fibres arise, which go to form the cerebellar peduncles. Luys does not admit the existence of commissural fibres connecting the two lateral halves of the cerebellum, and assumes that the decussation between the two sides, takes place through a special system of decussating prolongations from the cells of the cortical substance, which he calls intercortical commissural fibres. By the superior peduncles, the cerebellum is connected as are all of the cephalic ganglia, with the cerebrum; by the middle peduncles, the two lateral halves of the cerebellum are intimately connected with each other; and by the inferior peduncles, the cerebrum is connected with the posterior columns of the spinal cord.*

It is now universally admitted that an animal deprived of the cerebral hemispheres, is incapable of a spontaneous voluntary effort. Thus Vulpian says with regard to a rabbit from which he had removed the cerebral hemispheres and the corpora striata, that it was completely deprived of spontaneous volition; all its movements, which are, indeed, much less varied than those of a bird operated on in the same manner, are exclusively and directly due to a stimulation produced by exterior excitations or by interior inclinations, such as fatigue, etc., (*Système Nerveux, Paris*, 1866, p. 680.)

The observation of Pourfour du Petit, in 1766, connecting the loss of speech with disease of the left side of the cerebrum, the observation of Dr. Marc Dax, in 1836, who concluded from the loss of speech in one hundred and forty cases of right hemiplegia, that the faculty of language occupies the left anterior lobe, the reports of cases of aphasia, with lesion of the left anterior lobe by Broca, Aubertin, Charcot, Falret, Perroud and Trousseau, and the limitation of the lesion, by M. G. Dax, in 1863, to the anterior and middle part of the *left anterior lobe*, and the subsequent observations of Broca, Huglings-Jackson, Sanders, Moxon, Ogle, Bateman, Bastian, Von Benedict, Braunwart, Austin Flint, Wilbur, Seguin and others, indicating that the most frequent lesion, in *aphasia*, is in the parts supplied by the left middle cerebral artery, particularly the lobe of the insula, or the island of Reil, have not only rendered it probable that the organ of articulate language is restricted to these parts, but has sustained the view so long held by certain physiologists, that special portions of the cerebral substance, are connected with the exercise of special intellectual faculties.

As we have seen, various physiological and pathological writers, and more especially Rolando, Flourens, Desmoulins, Magendie, Longet and Vulpian, have held that a great part of the cerebral substance is neither excitable, nor sensible to direct stimulation; but the more recent experiments of Fristch and Hitzig, appear to have opened a new field of physiological investigation, and indicate that certain portions of the cerebrum possess excitability, and that their action is confined to particular sets of muscles, Fritsch and Hitzig, after exposing the cerebral hemispheres of dogs, found that certain parts of the anterior portion responded to a feeble galvanic current. They applied the stimulation by means of two needles, conducting a feeble galvanic current, introduced through the grey into the white substances. Each galvanization produced movements restricted to particular sets of muscles; but it was difficult to say whether the contractions were due to stimulation of the white or of the gray substance. These observers claim to have determined different centres for the different muscles; the centre for the muscles of the neck was located in the middle of the frontal convolution; external to that, was a centre for the extensor and abductor muscles of the fore legs; and so on, other centres for sets of muscles being found in the anterior portion of the hemispheres. By passing an interrupted current through these parts, tetanus of particular muscles was produced. In other observations, when the gray substance was removed at the points mentioned, there was partial loss of power, but not paralysis, of the sets of muscles corresponding to the centres operated upon. The experimenters regarded this as due to a loss of *muscular sense*. In these experiments the action was always crossed. It was also found that after severe hæmorrhage, the excitability of the cerebrum quickly disappeared, which may account for the negative results obtained by previous observers. No motor properties were found in the posterior portions of the cerebrum.

These experiments of Fritsch and Hitzig, throw a new light upon the cerebral substance, for it has heretofore, always been found difficult to experiment upon the great encephalic centres without disturbing the physiological conditions so seriously, as to render the result of direct observation of this kind more or less indefinite.

Now that it is ascertained, that in all probability, these centres readily lose their normal properties, as a simple consequence of hæmorrhage and exposure of the parts, the results of the older experiments, in which the cerebral tissue was apparently shown to be incapable of receiving direct artificial impressions, must be received with doubt, and should be re-examined by these new methods of research.†

In the London Lancet, October 21st, 1871, No. xvii, p. 581, it is stated that the experiments of Fritsch and Hitzig, have been confirmed by Schiff. Schiff is of the opinion however, that the movements produced by stimulation of the brain's substance do not depend upon direct excitability of the brain, but are reflex, the result of irritation of parts concerned in tactile sensibility.

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* The Physiology of Man-Nervous System, by Austin Floret, Jr., M. D., pp. 317, 319, 360, 362.

† Fritsch and Hitzig, Uber die electrische Erregbarkeit des Grosshirns:—Archiv für Anatomie, Pysiologie, und Wissenschaftliche Medecin, Leipzig, 1870, S. 300 et seq. The Physiology of Man—Nervous System, by Austin Flint, Jr., M. D. New York, 1873, pp. 323-324.

More recently. Dr Edward Hitzig,* has published an account of the electrical exploration of the brain of an ape, with the constant and inductive current, with the following general results: The anterior central convolution is the general centre for the muscles of the body: and the special centres for the different sets of muscles were found distributed in it as follows: close to the great longitudinal fissure, separated from it about three millimetres, was the centre for the hinder extremities; that for the anterior limbs was found about three millimetres more to one side; and still seven millimetres farther in the same direction was the centre for the parts innervated by the facial nerve. Finally, close to the sylvian fissures, he found the centre of the muscles of the tongue, mouth and jaws. This last observation is interesting from the fact that lesions in the same neighborhood are so frequently connected with aphasia in the human subject.

Professor David Ferrier, † of King's College, London, has repeated the experiments of Hitzig and Fritsch, with the following general results:

The research was commenced with a view to test the accuracy of the views entertained by Dr. Hughlings-Jackson on the Pathology of Epilepsy and Chorea. As is well known, Dr. Jackson regards localized and unilateral epilepsies as depending on irritating or discharging lesions of the convolutions about the corpus striatum. In order to put this theory to the proof, Professor Ferrier, determined to expose the brain in various animals, and apply irritation to the surface after the method of Fritsch and Hitzig, who as we have seen, had shown that contractions of definite groups of muscles could be caused in dogs by passing galvanic currents through certain portions of the anterior regions of the brain. The progress of the research ultimately led to the endeavor to establish the localization of cerebral functions, not merely as regards motion, but also as regards sensation, and the other faculties of the mind. The experiments were repeated before the British Medical Association, at Bradford, in 1873; an account of the experiments were first published in the third volume of the "West Riding Lunatic Asylum Reports," for by the kindness of Dr. Crichton Brown, the superintendent of the Asylum, Dr. Ferrier was able to conduct his experiments there. An abstract by the author of his researches has also appeared in the Journal of Anatomy and Physiology, November, 1873, and it is from the preceding sources that we condense the following general conclusions of Dr. Ferrier.

The method of experimentation which Dr. Ferrier adopted, is to place the animal under chloroform, and gradually expose the surface of the brain by successive trephinings and removal of the skull by the bone forceps. In this way he has been able to expose the whole hemisphere. After removal of the dura mater, the points of blunted electrodes, in connection with Dubois Reymond's induction coil, are applied to the surface of the brain, without injury to the cortical substance.

1. The anterior portions of the cerebral hemispheres are the chief centres of voluntary motion and the active outward manifestation of intelligence.

2. The individual convolutions are separate and distinct centres; and in certain defined groups of convolutions, (to some extent indicated by the researches of Fritsch and Hitzig), and in corresponding regions of non-convoluted brains, are localized the centres for the various movements of the eyelids, the face, the mouth and tongue, the ear, the neck, the hand, foot and tail. Striking differences, corresponding with the habits of the animal are to be found in the differentiation of the centres. Thus the centres for the tail in dogs, the paw in cats, and the lips and mouth in rabbits, are highly differentiated and pronounced.

3. The results were such as to indicate with a degree of exactitude the localization in certain definite and easily defined regions the cerebral centres for various apparently purposive combined movements of the muscles of the limbs, as well as of the tail, the facial muscles and the muscles of the jaws and tongue. These are all situated in the anterior parts of the brain in advance of the fissure of Silvius, and the individual centres are marked off in the various external convolutions. The general plan is that in the superior external convolution, anterior and posterior to the crucial sulcus, the various movements of the paws, legs and tail are centralized: and it is shown that the differentiation of these centres is to a great extent characteristic of the animal's habits; the centre for the fore-paw in cats being much more highly differentiated than in dogs and rabbits.

The middle external convolutions govern movements of the eyelids, face and eyes, while the inferior and the Sylvian govern various movements of the whiskers, angle of the mouth, depressors of the lower jaw and tongue. In the convolutions posterior to the Fissure of Silvius, certain movements are described as resulting from irritation, viz: of the ears, eyes.

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* Berliner Klin, Wochenschrift, No. 6, Feb. 6, 1874. Also Chicago Journal of Nervous and Mental Disease, Vol. I, No. 2, page 232.

† British Medical Journal, 1873, Medical Times and Gazette, August 20th, 1873, p. 233. West Riding Lunatic Asylum Medical Reports, Vol. III, 1873.

Journal of Anatomy and Physiology, November, 1873, p. 152.

etc. There are indications of the situation in those regions of the centres of special sense, sight, hearing and smell.

4. The action of the hemisphere is in general crossed; but certain movements of the mouth, tongue, and neck are bilaterally co-ordinated from each cerebral hemisphere.

One of the most important conclusions drawn from the experiments, is, that the region which governs the movements of the mouth and tongue in cats and dogs, is the homologue of what is known as Broca's convolution in man, viz: the posterior part of the inferior frontal. This is further borne out by experiments on monkeys. The pathology of Aphasia is thus rendered comparatively simple. The memory of words is situated in that part of the brain which governs the movements of articulation. It is shown, however, by the experiments, that the brain is symmetrical, and that the corresponding part of each hemisphere produces exactly the same effects on opposite sides of the body. Generally the action is unilateral and crossed; but, as regards the mouth, the action is almost bilateral; and hence disease of one or the other side alone does not cause paralysis of the articulating muscles, because the other side is able to govern as before. The occurrence of loss of speech, with lesion of the left side, is attributed to the fact that most people are left-brained, and that, therefore, a lesion of the left side causes such an interference with the voluntary recalling of words, that the person is speechless, not because memory of words is utterly lost, as this exists in the undamaged side, but because he is unable to lay hold of the word which he wishes to express. With the education of the other side, however, the individual recovers the power of speech. During the interval of recovery of speech, only automatic expressions or interjections are uttered, which are evoked by a sort of reflex action, and unconnected with volition. The experiments indicate not an anatomical, but a physiological co-ordination through the media of the lower ganglia.

5. The proximate causes of the different epilepsies are, as Dr. Hughlings-Jackson supposes, discharging lesions of the different centres in the cerebral hemispheres. The affection may be limited artificially to one muscle or group of muscles, or may be made to involve all the muscles represented in the cerebral hemispheres, with foaming at the mouth, biting of the tongue, and loss of consciousness. When induced artificially in animals, the affection as a rule first invades the muscles most in voluntary use, in striking harmony with the clinical observations of Dr. Hughlings-Jackson.

It was found that in rabbits, cats and dogs, the application of the electrodes for a few seconds, induced almost immediately, on some occasions after the lapse of a distinct interval, violent unilateral epileptic convulsions. When the electrodes were applied, one at the anterior, and the other at the posterior part of the hemispheres, the convulsions were complete and violent in the whole of the opposite side of the body. As a rule, they commenced in the face, spread to the neck and upper extremity, and then invaded the hind leg and tail. Dilatation of the pupil, clonic spasms of the jaws, foaming at the mouth, and loss of consciousness, were induced when the fits were at their greatest intensity. Occasionally, spasmodic convulsions remained localized in one or other limb, or in some one muscle or group of muscles; and frequently, instead of a hasty epileptic attack, a series of choreic twitches alone were manifested, without any affection of sensibility or consciousness.

6. Chorea is of the same nature as epilepsy, dependent on momentary and successive discharging lesions of the individual centres. In this respect Dr. Hughlings-Jackson's views are again experimentally confirmed.

7. The corpora striata have crossed action and are centres for the muscles of the opposite side of the body. Powerful irritation of one causes rigid pleurosthotonos, the flexors predominating over the extensors.

8. The optic thalamus, fornix, hippocampus major, and convolutions grouped around it, have no motor signification, and are probably connected with sensation.

9. The optic lobes or corpora quadrigemina, besides being concerned with vision and the movements of the iris, are centres for the extensor muscles of the head, trunk, and legs. Irritation of these centres causes rigid opisthotonos and trismus.

10. The cerebellum is the coördinating centre for the muscles of the eye-ball. Each separate lobule (in rabbits) is a distinct centre for special alterations of the optic axes. These cerebellar oculo-motorial centres are brought into relation with the cerebellum as a co-ordinating centre for the muscles concerned in the maintenance of the equilibrium; and these functions are indicated as mutually depending on each other.

11. On the integrity of those centres depends the maintenance of the equilibrium of the body.

12. Nystagmus, or oscillation of the eye-balls, is an epileptiform affection of the cerebellar oculo-motorial centres.

13. Irritation of the nates causes great dilatation of the pupils. The action is crossed, but powerful irritation easily acts on both sides of the body. Trismus and opisthotonos are induced when the ganglia are powerfully stimulated.

At the Berlin Medico-Psychological Society in November, 1873, Dr. Hitzig,* the author of the method of the examination of the brain by electricity, made some remarks on the preceding experiments of Dr. Ferrier, and called attention to the important discrepancy, that whilst he and Fritsch had found only one part of the convexity of the hemisphere capable of electrical excitation, Ferrier extends this property to nearly the whole of it. This Hitzig explains by saying that Ferrier has in his experiments used too strong currents, (the secondary coil of Stöhrer's battery being pushed in to eight and even four centimetres), and has thus excited the ganglia at the base of the brain, so that it is to them, and not to centres localized in the cortex, that the movements noted must be referred. Another reason why Hitzig doubts some of the effects of irritation in Dr. Ferrier's cases, is because, although, there is such a remarkable anatomical similarity between the brains of the dog and the cat, the latter found that electrisation of the spot on the cat's brain corresponding to the centre of movement for the tail in the dog gave no result. Hitzig has repeated several of the experiments in which Ferrier's results differed from his own, and declares that his own views are re-affirmed. M. Carville† presented on behalf of himself and M. Duret, at the *seance* of the *Soc. de Biologie*, Jan. 3, (Report in Gaz. Med. de Paris, Jan. 24), a communication relative to the excitability of the cerebral hemispheres by faradic currents, in which he criticised the recent investigations of Dr. Ferrier, in regard to the location of the functions of the brain. The effort is made to show that the phenomena described by Ferrier and others, are not due to localized excitation of cortical centres, but to transmitted irritation of the cerebral ganglia and peduncles. M. Carville and M. Duret, repeated the experiments of Dr. Ferrier, and then afterwards endeavored to obtain the same results when the animal was completely under the influence of anæsthetics, but found them altogether different. Thus, when the anæsthesia was imperfect, it was possible by applying the electrodes successively to the surface of the convolutions, to reproduce some of the movements described by Ferrier. For example, the excitation of the anterior portion of the external superior convolution, caused the raising of the fore paw, the flexion of the toes, the elevation of the shoulder, etc., of the opposite side: while on the other hand, the excitation of the second and third external convolutions produced a rotation of the head towards the opposite side. Some of these movements, the experimenters attributed to electric excitation of the muscles by the liquids which bathe the surface: others to the direct diffusion of the excitation through the substance of the cerebrum: and test experiments appeared to demonstrate the correctness of both of these suppositions.

When anæsthesia was complete, no effects were obtained by the excitation of the convolutions with any intensity of the current. Neither the centres described by Ferrier as regulators of the associated movements of the fore-paw, in those of the posterior paw, or the lips, or the eye-lids, were manifested by electric irritation.

These results are explained by the hypothesis, that the currents applied to the surface, act only by exciting the corpus striatum and the peduncles: or, in short, those portions of the cerebrum which are known to be excitable. Anæsthetics affect the medulla, and through it gradually suppress the excitability of the various organs. When, therefore, the animal experimented upon is under their influence, the diminished excitability requires stronger stimulus, until, when the loss of sensibility is complete, the reaction ceases altogether.

The following are the conclusions of M. Carville:

The peripheral layer of the hemisphere, is unexcitable, insensible, and contains no motor centres.

The effects obtained by faradization, which penetrates to the corpora striata and peduncles, are due to the direct excitation of these organs.

These effects cannot be attributed to any reflex action. Complete anæsthesia, which hinders these effects, does not at all change the conditions of the peripheral stratum of the hemispheres, but acts merely by more or less diminishing the excitability of those parts of the hemisphere which are universally recognized as excitable.

M. Dupuy‡ in a note presented to the Soc. de Biologie January 3d, 1874, holds that:

The conclusions of M. Ferrier cannot be accepted because that observer did not attempt to find out whether the electric currents (faradic as he terms them) which he used in his experiments, diffuse themselves or not through the encephalon. By the aid of a galvanoscopic frog M. Dupuy has been able to prove that in fact they are so diffused, and that we cannot consequently claim any more than before, that the cortical layer of the brain is excitable by electricity.

We cannot localize the primitive or functional centre of any nervous conductor in a particular cerebral convolution as Ferrier supposes because when the animal operated on is completely anæsthetized electrical irritation of the cortex causes no contractions; while in the same animal, and with the same electrical current, the direct irritation of the sciatic nerve previously laid bare causes a contraction of the muscle to which it is distributed.

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* Medical Times and Gazette, January 24th, 1874, p. 106.

† Chicago Journal of Nervous and Mental Disease, Vol. 1, No. 2, April, 1874, p. [illegible]

‡ Chicago Journal of Nervous and Mental Disease, Vol. 1, No. 2, p. [illegible]

Dr. Roberts Bartholow,[*] of Cincinnati, has had the boldness to apply this method of cerebral exploration to the human subject.

A woman thirty-two years old and of feeble intellect, was admitted to the Good Samaritan Hospital in Cincinnati, on account of an epethelioma which had destroyed some two inches of the top of the skull, leaving the dura mater exposed.

Dr. Bartholow, anxious to repeat in the human subject the experiments of recent investigators of the function of the brain, proceeded to apply powerful galvanic and faradic currents to the dura mater, and to the substance of the brain, by needles of various lengths insulated to near the points. The needles, during the three weeks of experimenting, were introduced about ten times in each hemisphere, to the depth of from a twelfth part of an inch to an inch and a half, and at distances varying from a quarter of an inch to an inch.

The first point demonstrated was the insensibility of the dura mater and the brain substance itself; the patient was absolutely unconscious of the presence of the needle when introduced, though in the entire possession of her faculties. The presence of the needle itself, when it penetrated a certain depth, was felt by the patient, not where the needle was, but in the extremities on the side of the body opposite to that of the hemisphere of the brain penetrated, chiefly in the hand and arm. When the needles were connected with the galvanic battery, distinct muscular movements occurred on the side opposite to the hemisphere of the brain in which the needles were. The pain experienced in the extremities was also much more decided. Choreic movements were excited on the side of the body opposite to that of the brain in which the needles were plunged. A stronger electric current applied to the right hemisphere, caused the unilateral epilepsy of the opposite side, of great violence.

The following experiment was made to test faradic re-action of the posterior lobes:

> "Passed an insulated needle into the left posterior lobe, so that the non-insulated portion rested entirely in the substance of the brain. The other insulated needle was placed in contact with the dura mater, within one-fourth of an inch of the first. When the circuit was closed, muscular contraction of the right upper and lower extremities ensued, as in the preceding observations. Faint but visible contraction of the left orbicularis palpebarum, and dilatation of the pupils also ensued. Mary complained of a very strong and unpleasant feeling of tingling in both right extremities, especially in the right arm, which she seized with the opposite arm and rubbed vigorously. Notwithstanding the very evident pain from which she suffered, she smiled as if much amused.
>
> The needle was now withdrawn from the left lobe and passed in the same way into the substance of the right. When the current passed, precisely the same phenomena ensued in the left extremities and in the right orbicularis palpebarum and pupils. When the needle entered the brain substance, she complained of acute pain in the neck. In order to develop more decided re-actions, the strength of the current was increased by drawing out the wooden cylinder one inch. When communication was made with the needles, her countenance exhibited great distress, and she began to cry; very soon, the left hand was extended, as if in the act of taking hold of some object in front of her; the arm presently was agitated with clonic spasms; her eyes became fixed, with pupils widely dilated; lips were blue, and she frothed at the mouth; her breathing became stertorous; she lost consciousness, and was violently convulsed on the left side. The convulsions lasted five minutes, and were succeeded by coma. She returned to consciousness in twenty minutes from the beginning of the attack, and complained of some weakness and vertigo.

Two days later the patient was brought down for similar experiments with the galvanic current: "She was pale and depressed, her lips were blue, and she had evident difficulty in locomotion." The electrical excitement caused rhythmical convulsions of the right side of the neck and right arm. The experiment was discontinued. The next day she died. The autopsy showed great congestion of the brain, and purulent exudation on the left side. There was a thrombus in the longitudinal sinus, which lay nearly in the centre of the ulcer. The inflammation was greatest at the points not at all touched by the needles, but their tracks were marked by lines of "*diffluent cerebral matter.*"

It is evident that precisely the same objections which have been urged against the experiments of Dr. Ferrier hold good against those of Dr. Bartholow upon this poor, defenceless, miserable patient of the *Good Samaritan Hospital!* of Cincinnati, viz: That the currents affected simultaneously all the ganglia at the base of the brain, being diffued to regions far distant from those included between the points of the needles.

Professor Gudden,[†] of Zurich, has instituted important researches upon the nervous system, which consist in taking young animals immediately after birth, and removing or wounding portions of the nervous system, and then permitting the animal to grow up, the effects of the lesion upon the subsequent development of the animal being carefully watched. By this method of experimenting he has fixed the centre for voluntary motion in the anterior lobes of the cerebral hemispheres, and in this respect reaching a result similar to that obtained in the preceding experiments with electrical excitation of the various portions of the brain.

MM. Fournie and Beaunis,[‡] in France and Nothnagel[||] in Germany, have endeavored to determine the functions of the brain by destroying circumscribed portions. Thus the

[*] Cincinnati Enquirer, March 24, 1874.
Chicago Journal Nervous and Mental Disease, Vol. 1, No. 2, p. 233.
American Journal Medical Sciences, April, 1874.
Boston Medical and Surgical Journal, April 30, 1874, p. 433.

[†] Archiv. fur Psychiarie und Nervenkran kheiten, Band II, 1870, page 693.

[‡] Recherches Experimentales sur le Fonctionnement d'u Cerveau, per le Dr. Edouard Fournie, Paris, 1873,

[||] Virchow's Archiv. f Path. Anat. u f. Klin. Med., Band. 57, 2d heft., pp. 184–214.

[illegible] generally [illegible] the influence of chloroform, and a small [illegible] minute quantity of a [illegible] of a syringe [illegible] that part of the [illegible] was seen by Nothnagel, and [illegible] Such experiments cannot [illegible] the nervous substance.

[illegible] many parts of the nervous substance are, apparently, [illegible] in different groups of [illegible] destruction of a small portion of the rabbit's brain [illegible] convulsions of the anterior side of [illegible] He also found [illegible] the hemispheres, the irritation of which in some [illegible] the opposite side of the body. This [illegible] the animal [illegible] the use of its [illegible] as the centre for motion in the affected [illegible] Nothnagel [illegible] in the white substance in the [illegible] on the opposite side of the body. Further [illegible] a movement of [illegible] plane.

When the [illegible] was the seat of lesion, various phenomena were noted, according [illegible] destruction of one of these bodies there [illegible] of the body [illegible] in two cases in which [illegible] was the seat of the lesion, another effect [illegible] of the animal, which was often continued until [illegible]

[illegible] Nothnagel [illegible] Virchow's Archiv, vol. [illegible] a continuation [illegible] of the brain [illegible] series of experiments, numbering [illegible] method of investigation [illegible] the injection of [illegible] selected [illegible] He now [illegible] where the animals [illegible] springing [illegible] hemispheres. In sixty experi[illegible] the animal was [illegible] Nothnagel believes that [illegible] phenomenon of experimental nerve-physiology [illegible] The animal [illegible] is impelled either [illegible] in which it is sometimes [illegible] against the wall [illegible] are made. These symptoms rapidly disappear, and the [illegible] after the operation. The exact spot in the [illegible] must be penetrated to pro[illegible] The spot lies over the [illegible] the needle were introduced too far.

Experiments made [illegible] so as to irritate the [illegible] negative results [illegible] substances [illegible] the superficial layer [illegible] towards the base, dis[illegible] extremities, often [illegible] produced by pricking [illegible] their head to the [illegible] of the free legs was [illegible] passed off.

Nothnagel [illegible] whether [illegible] ganglionic, whose de[illegible] a compact mass, but are scattered through the substance of the thalamus, so that injury to a part of them by the simple puncture is compensated for by the others which remain intact.

Nothnagel's results with regard to the hippocampus major and optic thalamus, thus agree in many points, with those of Dr. Ferrier on the same parts, by the method of electrical irritation, but the latter found no motor disturbances on stimulating the thalamus.

I have thus endeavored to present the general history of results of the following methods of research which have been employed for the determination of the functions of the cerebrum and cerebellum.

1. Minute Structure and Anatomical Relations of the Brain and Spinal Cord.
2. Comparative Anatomy and Physiology of the Cerebro-Spinal Nervous System.
3. Effects of Disease and Pathological lesions upon the component parts of the Cerebro-Spinal System.
4. Disturbances of nervous functions by sections of the different ganglionic masses.
5. Irritation or excitation of definite portions of the brain, by means of electric currents.
6. Destruction of definite portions of the brain in young animals, and observations upon the effects of such lesions upon the nutrition and growth.
7. Destruction of small portions of the brain, by the injection of corrosive solutions, and by small needles introduced into its substance.

RELATIONS OF THE CEREBRO-SPINAL AND SYMPATHETIC NERVOUS SYSTEMS.

Whilst endeavoring to present a general view of the advance of knowledge with reference to the functions of the Sympathetic Nervous System and its relations to the Cerebro-Spinal System, we shall also record the facts illustrating the relations of the nervous system to Nutrition, Secretion, Circulation, Respiration and Inflammation.

As far as possible the plan of the preceding portions of this Chapter will be carried out and the more important facts and researches presented in the order of their discovery and execution.

The observations and experiments of Rufus Ephesus,[1] Galen,[2] Piccolhomini,[3] Riolan,[4] Plempius,[5] Wills,[6] Chirac, Bohn,[7] Duverney, Vieussens,[8] Schrader, Valsalva, Morgagni, Baglivi, Berger,[9] Ens, Senac, Heuermann, Haller,[10] Brunn,[11] Molinelli, Petit,[12] Fontana,[13] Cruikshank, Haighton, Meyer, Bichat,[14] Dupuytren,[14a] Dumas,[15] Blainville, Provencal,[16] Vesalius, Columbus, Riolan,[17] Bidloo,[18] Muralto, Courten, Drelincourt,[19] Martin,[20] Emmet, Portal, Prochaska,[21] Winslow,[22] Le Gallois,[23] Philip, Lobstein,[24] Reid,[25] Krimer, Arnemann, Longet,[26] Brodie,[27] Chossat,[28] McCartney,[29] Nasse,[30] Bernard,[31] Hall,[32] Brown-Séquard,[33] and others, have demonstrated that to the nervous system is delegated the property of regulating the action of the organs and apparatus, and thus regulating the amount of oxygen and blood supplied to the organs and tissues and apparatus.

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[1] Appellationes, Part. Hum. Corp. Græcé. Parisiis, 1554, p. 32.

[2] Galeni Opera. Venetiis, apud Juntas, 1576, de Hippocr. et Plat. decretis, lib. ii. cap. vi. p. 239.

[3] Anatomicæ Prælectiones Archang. Piccolhomini, Romæ, 1586.

[4] Opera Anatomica. Lutetiæ Parisiorum, 1649.

[5] Fundamenta Medicinæ. Lovanii, 1644.

[6] Opera Omnia, edente Blasio. 1682, tom. i. Nervorum Descriptio.

[7] Circulus Anatom. Physiol. Lipsiæ, 1697.

[8] Treatise on the Heart, Toulouse, 1715.

[9] Physiologia Medica, Francofurti, 1737.

[10] Mémoires sur les parties sensibles et irritables, tom. i.

[11] Commentarii de rebus in Scient. Nat. et Medic. Lipsiæ, tom. iv.

[12] Mémoires de l'Académie des Sciences, an. 1727.

[13] Traité sur le Venin de la Vipère.

[14] Recherch. Phys. sur la Vie et la Mort.

[14a] Inséré dans la Biblioth. Médic., tom. xvii. p. 1. Physiological Researches on Life and Death, by Xavier Bichat, trans. by F. Gold, London.

[15] Journal Général de Médecine, par M. Sédillot, tom. xxxiii.

[16] Bulletin des Sciences Médicales, tom. v.

[17] Encheiridium Anatom Parisiis, 1658. Opera Anatomi.

[18] Exercitationes Anatom. Chirurg. Lugd. Batav., 1708.

[19] Experimenta Anatom. Lugd. Batav., 1681.

[20] Essais et Observ. de Médecine de la Société d'Edimbourg, Paris, 1742.

[21] Opera Minora. Viennæ, 1800, tom. ii.

[22] Exposition Anatom. Traité des Nerfs.

[23] Experiments on the Principle of Life, and Particularly on the Principles of the Motions of the Heart, and the seat of this Principle, by M. Le Gallois. Translated by N. C. and J. G. Nancrede, Philadelphia, 1813.

[24] Structure, Functions and Diseases of the Human Sympathetic Nerve, by John Fred. Lobstein. Translated by Joseph Pancoast, M. D., Philad., 1831.

[25] "An Experimental Investigation into the Functions of the Eighth Pair of Nerves," by John Reid, M. D. Edinburg Medical and Surgical Journal, 1838.

[26] Traité de Physiologie, Paris, 1850, t. ii.

[27] Medico-Chirurg. Trans., 1837, vol. xx. p. 132

[28] Mémoire sur l'influence du syst. nerv. sur le chal. anim. Thése de Paris, No. 126, 1820.

[29] Treatise on Inflammation, 1838. p. 13.

[30] Untersuchungen zur Physiol. und Pathol., 1839, vii.

[31] Gaz. Médic. de Paris, vol. vii. No. 14.

[32] Phil. Trans., 1833. On the Diseases and Derangements of the Nervous System, by Marshall Hall, M. D., London, 1841.

[33] Experimental Researches applied to Physiology and Pathology, by E. Brown-Séquard, New York, 1853.

The blood supplying the nutritive elements of the tissues and organs, and the materials for the secretions and development of the forces, and oxygen being the active agent in all the chemical actions of living bodies, it is evident that whatever disturbs the constitution of the nervous system, necessarily disturbs the functions of the apparatus and organs, and produces corresponding alterations in their secretions and excretions.

As the integrity of the nervous system depends upon the integrity of the blood, in like manner whatever alters the constitution of that fluid will produce aberrated action in the nervous system and in turn, this disturbance may extend itself indefinitely.

Disease, then, whether arising in the organs, or in the blood, or originally in the nervous system, will always be attended by aberrated nervous action. The most prominent symptoms of disease will be manifested by the nervous system.

In investigations into the causes and effects of disease, we should consider the distinction between the offices and phenomena of the two systems of nerves, the cerebro-spinal and sympathetic.

Long before Haller, the intellectual functions, sensation, and voluntary motions, had been distinguished from those which are exercised without our knowledge, and over which our will has no command, such as circulation, nutrition, and secretion. The former were distinguished under the name of external animal functions, and the latter under the name of internal natural functions, and both orders of functions were known to be equally under the control of the nervous power. Willis[*] asserted the distinction between the nerves destined to voluntary motions and those which preside over the internal natural functions which are independent of the will. He placed the origin of the nerves of the external animal functions in the cerebrum, and that of the nerves of the internal natural functions in the cerebellum, and contended that if the motions of the heart as well as the other vital functions do not undergo any interruption, it is because the action of the cerebellum continues without ceasing; whilst on the contrary the voluntary motions require repose, because the action of the brain is intermittent.

Boerhaave[†] adopted the opinions of Willis, and in the action of the heart, in addition to nervous action, he admits two other causes of its motions, and their harmony: the action of the blood of the coronary arteries upon the fibres of the heart, and of the venous blood in the internal surfaces of the cavities of the heart. Recent experiments[‡] have rendered this opinion of Boerhaave more than probable.

In 1752, Haller published his experiments upon irritability, which tended to establish the existence of an internal life independent of the nervous power, and demonstrated that the cause of animal motion resided in the muscular fibre itself. The opinion is now gaining ground with physiologists that the contraction of the muscles and all animal motions result from the chemical changes of the elements of the muscles and blood. Haller admitted that whilst the irritability of the muscles is the cause of all animal motions, it cannot produce them without a stimulus, and that the nervous power is the natural stimulus of all those which are submitted to the will, whilst the involuntary muscles acknowledge stimuli of various sorts, which are appropriate to their functions, and wholly abstracted from the nervous power. According to Haller, the blood is the natural stimulus of the irritability of the heart; and alimentary substances the natural stimuli of the intestinal canal: and the motions of these organs are not submitted to the will because they are independent of the nervous power. This theory of Haller, although imperfect, and in some respects erroneous, nevertheless expressed great truths which are now being demonstrated. Careful experiments demonstrate that Haller was in error when he asserted the independence of the heart and the intestines of the nervous system; and Prochaska,[‖] in 1784, admitted the nervous power as one of the conditions necessary to the manifestation of irritability, and accounted for the fact that the motions of the heart were not stopped by the entire suppression of all communication between the brain and the heart, by the abandonment of the then generally received opinion that the brain was the centre and only source of the nervous power, and by the adoption of the opinion that the nervous power is produced in the whole extent of the nervous system, even in the smallest nerves, and that it can exist independently of the brain, for a certain time.

Willis[1] and Vieussens[2] acknowledged the general relations of the sympathetic system with the cerobro-spinal, and considered the sympathetic as the medium by which the sympathetic relation is tendered so remarkable between the cerebrum and the viscera of the middle and lower parts of the abdomen, and noticed the important physiological and pathological facts that not only do the various conditions of the brain affect the viscera, but the affections of the viscera affect the brain as well as the mind itself.

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[*] Tho. Willis opera omnia, edente Ger. Balsio. Amstelodami, 1682. Tom. i. de Cerebri Anatome, cap. xv.

[†] Her. Boerhaave Inst. Medicæ, § 400. Vanswieten in Aphorismos, etc. Lugduni Batav., 1745. Tom. ii.

[‡] Brown-Séquard.

[‖] Commentatio de Functionibus Systematis Nervosi, 1784.

[1] Nervorum Descriptio et Usus. Cap. xxvi. Opera Omnia. Geneva, 1695, tome i.

[2] Neurograph. Univers., lib. 3 de Nervis, cap. v.

Dr. Robert Whytt of Edinburg, to whose important "Essay on the Vital and other Involuntary Motions of Animals," published in 1751, we have alluded in the discussion of the history of the doctrine of *reflex action*, promulgated fourteen years afterwards in 1765, his "Observations on the Nature, Causes and Cure of those Disorders which have been commonly called Nervous Hypochondriac or Hysteric," a work which abounds with valuable clinical facts illustrating the "*Sympathy*" of the nerves.

In the first chapter, in which he discusses the "Structure, Use, and Sympathy of the Nerves," Dr. Whytt enumerates various instances of sympathetic actions and discusses the mode of their production. Thus he says:

> "Our bodies are, by means of the nerves, not only endowed with feeling and a power of motion, but with a remarkable sympathy, which is either general and extended through the whole system or confined in a great a measure to certain parts.
>
> That every sensible part of the body has a sympathy with the whole, will sufficiently appear from the following facts:
>
> Cold water thrown on any part of the body that is warm, produces a sudden contraction of the whole vessels and pores of the skin, and by that means frequently puts a stop to small hæmorrhages. * *
>
> When the brain is wounded, inflamed, suppurated, or otherwise hurt, almost every part of the body is liable to suffer, and vomitings, tremors, convulsions, palsies, &c., often ensue. In animals newly dead, the whole muscles of the trunk and extremities are strongly convulsed, when a probe is pushed down through the spinal marrow. * *
>
> A fever, *delirium*, and violent convulsions, have been produced by a pin sticking in the coats of the stomach:(a) And worms, affecting either this part or the intestines, occasion a surprising variety of symptoms.
>
> Epileptic fits have proceeded from a rough bone or cartilaginous substance, irritating the nerves of the great toe, or the calf of the leg; and the wound of a tendon or nerve has been the cause of a fever, *delirium*, tremors, violent convulsions, a *tetanus* and death. * *
>
> Besides this general *consent* which prevails throughout the whole body, there is a particular and very remarkable sympathy between several of its organs, by means of which many operations are carried on in a sound state; and pain, convulsive motions, and other morbid symptoms are often produced in such parts, as have no near connexion with those that are immediately affected. * * Grief, vexation or fear, lessen the secretion of the *saliva*, destroy the appetite, and sometimes occasion a looseness. The great consent between the brain and the heart appears from the sudden and remarkable effects of the passions on the latter. When one eye is affected with an inflammation, a cataract, or the *gutta serena*, the other is often soon after attacked with the same disease. The contraction of the pupil is not owing to light acting as a *stimulus* on the *iris*, but solely to the sympathy between this membrane and the retina, * * The noise of a file and other harsh sounds affect the teeth with an uneasy sensation. The whetting of a knife has caused the gums to bleed. * * The effluvia of Hungary water, or spirit of wine drawn strongly into the nostrils, increase the derivation of the salival juice into the mouth, and sometimes stop a tickling cough. The smell of grateful food makes the *saliva* flow when one is hungry. Sternutatories not only increase the secretion from the nose, but also from the lachrymal vessels. * * A pain in the teeth often affects the cheek bone, one side of the head, the throat, and the corresponding ear. Children, from the irritation of the gums in teething, are liable to vomiting, purging, a cough, a fever and convulsions. * * A disordered state of the stomach and intestines, with wind or noxious humours lodging in them, will sometimes so affect the brain, as to deprive people of their reason. At other times, the same causes will produce a vertigo, *cephalæa*, *hemicrania*, *clavus hystericus*, palpitations, intermissions of the pulse, difficulty of breathing, sudden flushes of heat and sweating. * *
>
> A *nausea* or disagreeable sensation in the stomach makes the pulse quicker and smaller, raises a sweat, and sometimes greatly increases the secretion of the *saliva* or urine. When the stomach is empty and affected with a sense of hunger, the salival juice flows much more copiously into the mouth, than after a full meal, or when the natural appetite for food is wanting. * *
>
> An inflammation of the intestines is frequently attended with vomiting and a suppression of urine. An *opisthotonos* or a *tetanus* is often occasioned in hot climates, by a retention of the *meconium*, or other acrid humours, in the bowels of infants. That itching of the nose, which is a common sign of worms, seems to indicate a peculiar sympathy between this part and the intestines; and the many other symptoms produced by worms, which I shall have occasion to mention afterwards, show a remarkable and extensive consent between the first passages, and many other parts of the body. Stones irritating the biliary ducts, frequently occasion a *nausea* and vomiting. * * A *nausea*, vomiting, costiveness and inflammation of the bowels, are often produced by an inflammation in the kidneys, or stones in the urethra. * * An irritation of the neck of the bladder, or extremity of the rectum, is the cause of a constant contraction of the diaphragm and abdominal muscles. A strangury and *tenesmus* mutually occasion each other. * *
>
> At the time of puberty, not only the voice, but the whole body undergoes a sensible change, which is probably owing to the *stimulus* communicated to the nerves of the genital parts by the *semen*; for we certainly know that other *stimuli* applied to the nerves of the nose or stomach according to their nature, will either instantaneously impart new vigor to the whole body, or soon occasion a general *stupor* and debility. It is owing to a sympathy with the *glans*, that the *vesiculae seminales* are contracted in time of coition; and, when the membrane which lines the lower part of the *urethra* is stimulated by the *semen*, the *acceleratores urinæ* are excited into convulsive motions.
>
> The great variety of symptoms in the hysteric disease is the reason, why a more extensive sympathy has been ascribed to the womb, than to any other part, except the brain. * The vomiting which generally accompanies an inflammation of that organ, the *nausea*, and depraved appetite after conception, the violent contraction of the diaphragm and abdominal muscles in delivery, the headach, and the heat and pain in the back and bowels about the time of menstruation, are sufficient proof of the *consent* between the *uterus* and several other parts of the body. But there is no part so much affected by the different states of the womb as the breasts, which become more turgid before any appearance of the *menses*, and subside after the period is over. The changes that happen to the breasts in time of pregnancy, and after delivery, are still more remarkable." pp. 9–29.

The observations and researches of Winslow,[1] Girardi and Fontana,[2] Jacobson,[3] Lobstein,[4]

(a) Hildan, Centur. ii., Observat. 34.

[1] Exposition Anatomique, Traité des Nerfs.
[2] Journal de Médecine, Chir. et Pharm., par Bacher, tom. xciii.
[3] Acta regiæ Societatis Hafniensis Medicæ, vol. v. Hafniæ.
[4] Structure, Functions, and Diseases of the Sympathetic Nerve, by J. F. Lobstein. Trans. by J. Pancoast. Philadelphia, 1831.

Ribes.[1] Killian,[2] Laumonier,[3] Cloquet,[4] Scarpa, Hasse, and others, established the structure and distribution and communications of the sympathetic system of nerves, and laid the foundation for the philosophical generalizations of the physiological and pathological phenomena.

Scarpa demonstrated by actual experiments, that the sympathetic system receives nerves from all parts of the nervous system, the brain and spinal marrow, and that all the viscera receive nerves composed of many separate filaments from different sources.

Würtzel divided all the ganglia of the sympathetic system into three orders, the cerebral, spinal, and vegetative, and affirmed that they differed essentially from each other in their structure, and in their behavior under the action of chemical agents.

Prochaska distinguished the nerves of motion from those of sensation, and affirmed that, the heart cannot contract itself, unless the inpression of the stimulus upon its cavities is transmitted to the ganglions of the system of vegetative life, through the nerves of sensation, and thence reflected to the fibres of the heart, through the nerves of motion. Whilst admitting the connection of the sympathetic system with the action of the heart, he is confused and uncertain in his account of the functions of the ganglions, which he appeared to consider as knots and ligatures, tight enough to intercept all communication in the calm and quiet state, but not sufficiently tight to prevent the action of the nervous force, generated in the brain during the agitation of the passions. He asserted that it is through the nerves of the eighth pair that the effect of the passions is felt upon the heart.

In common with Winslow, Winterl, Johnstone, and others, Prochaska believed that the ganglia of the sympathetic system were so many little brains capable of supplying the necessary force to the viscera.

We have already presented an extended analysis of the views of Prochaska and Unzer, and directed attention to the fact, that the former writer, noticed the influence of the nervous system over the blood vessels, and especially the capillaries, and referred the congestion and increased secretion induced by local irritants, and certain medicines, as purgatives, not merely to the irritation of the extremities of the nerves, but to a reflex action.

Pourfour du Petit [1712 and 1725, *Mémoire dans lequel il est démontré que les nerfs intercostaux fournissent des rameaux qui portent des esprits dans les yeux. Mémoires de l'académie royale des sciences, Année*, 1727, *Paris*, 1729, *p.* 5 *et seq.*] demonstrated that the division of the trunk of the sympathetic nerve, which he termed *nervus intercostalis*, opposite the fourth or fifth cervical vertebræ in dogs, was rapidly followed by great disturbance in the circulation of the eyeball, and attended with inflammation, flattening of the cornea, retraction of the eyeball, with protrusion of a fold of the conjunctiva, a flow of tears, and ultimately with ulceration and destruction of the entire organ. These experiments appeared to demonstrate that the influence of the sympathetic was propagated from below, upward toward the head, and not from the brain downward: and are justly regarded as the starting point of our definite knowledge of the functions of the sympathetic system, although they illustrated only the influence of the cervical portion upon the eye. The investigations of Pourfour du Petit, were subsequently repeated and extended by various observers, as William Cruikshank,[5] Arneman,[6] Dupuy,[7] Dr. John Reid,[8] Magendie,[9] Molinelli,[10] Mayerof Brun,[11] Braschet,[12] Brown-Séquard,[13] Claude Bernard,[14] and other physiologists.

William Cruikshank, in 1776, performed important experiments upon the par-vagum, and Intercostal or sympathetic nerves, [Phil. Trans. 1795, p. 177], with the following results Section of the right par-vagum and right intercostal [sympathetic], was followed in a dog, by heaviness, slight inflammation of the right eye, difficulty of respiration, sullenness, and a disposition to keep quiet. The unfavorable symptoms did not continue above a day or two; and on the eighth day, the dog seemed to be perfectly recovered. The experiment was then repeated upon the left side, of the same dog, but instead of a mere section, about one inch of the left *par-vagum* and intercostal nerves were removed. The eyes of the dog became instantly red and heavy, his breathing was more difficult than in the former experiment: the saliva was ropy, increased in quantity and flowed from the mouth, the pulse was increased to 160 per minute. Notwithstanding these symptoms, the dog ate and drank even voraciously at times. In breathing, the inspirations were low and deep, the expirations were attended with repeated jerks of the abdominal muscles. The seventh day after this second operation, the dog was found dead, and upon post-mortem examination, everything seemed to be normal, but the lungs, which contained little or no air, were of a red-brown color and resembled more the substance of liver than of inflamed lungs, and sank to the bottom when thrown into water The inner surface of the trachea and its branches, appeared to be exceedingly inflamed, and covered with white fluid, in some places resembling pus, and in others ropy, and more of the nature of mucus.

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[1] Dictionnaire des Sciences Médicales, tom. lvi.

[2] Anatomische Untersuchung uber das Neunte Hirnnervenpaar, Pesth, 1822.

[3] Journal de Médecine, Chirurgie et Pharmacie, par Bacher, tom. xciii.

[4] Traité d'Anatomie Descriptive, tom. ii.

[5] Experiments on the Nerves, particularly on their Reproduction; and on the Spinal Marrow of Living Animals. by William Cruikshank Phil. Trans. 1795 p. 177.

[6] Göttingen, 1787.

[7] Journal de Médecine, Chirurgie, etc., Decembre, 1816, tome xxxii, p. 340.

[8] Edinburgh Medical and Surgical Journal, August, 1839.

[9] Anatomie des Systemes Nerveux, etc., tome xi, p. 716.

[10] Comment Bononiensi, tome iii, 1755.

[11] Journal du Chirurgie, 1827.

[12] Recherches Experimentales, sur les Functions du Système Nerveux Ganglionnaire.

[13] Experimental Researches, applied to Physiology and Pathology—Medical Examiner, Phila. August, 1852, New Series, vol. 8, p. 487.

[14] Comptes Rendus de la Société de Biologie, Paris, 1851, tome iii, p. 163.

In another experiment, in which the par-vagi and intercostals of both sides were simultaneously divided, the eyes of the dog became instantly dull and heavy; he tottered as he walked; foamed at the mouth; vomited; breathed with excessive difficulty, and his inspirations being long and deep, and his expirations short and sudden, attended with a loud bark. Next morning, Mr. Cruikshank, found the dog apparently dead; but on examining more attentively, found that he breathed still, though exceedingly slow, his pulse was gone, he felt cold, and his limbs were stretched out. When placed before a warm fire, the dog revived to a considerable extent, and manifested phenomena similar to those exhibited just after the operation. In the afternoon the dog died, having survived the operation twenty-eight hours. The lungs in the dead body, were loaded with blood, but not to such an extent as to cause them to sink in water.

Mr. Cruikshank, repeated the experiments upon other animals, with similar results. In his experiments upon the division of the spinal marrow in the cervical region, Mr. Cruikshank observed that there was a decided fall of temperature.

The idea that the sympathetic was a distinct nerve, appears to have been originally broached by Söemmering; who said, "it is a nerve that exists independently, and is only connected with the cerebral aud spinal nerves." The older anatomists, considered the sympathetic with Haller as a cerebral nerve, or with Petit as a spinal nerve.

Bichat, as we have shown by an analysis of his works on Life and Death, was the originator of the doctrine of an organic system of nerves, and however erroneous and confused many of his statements aud doctrines may now appear, it is without doubt true that the clearness and eloquence with which he presented his theories, stimulated careful investigation, as well as decided opposition.

Bichat acknowledged an animal and organic life distinct from each other, and affirmed that the sytem of ganglions (sympathetic system) belonged entirely to the organic life, and that the cerebral system belonged entirely to the animal.

Whilst Bichat understood the influence of the several parts of the nervous systems, he failed to recognize their mutual connections. The mutual relations of these systems were established by the experiments of Le Gallois.

Le Gallois, by an extensive series of experiments, arrived at the following conclusions:—

> "Life is produced by an impression of the arterial blood made upon the brain and medulla spinalis, or by a principle resulting from this impression.
>
> "The prolongation of life depends upon the continued renewal of this impression. * *
>
> "It is this impression, this principle formed in the brain and spinal marrow, which, under the name of nervous power, and through the medium of the nerves, animates all the rest of the body, and presides over all its functions.
>
> "The heart derives all its powers from this principle, as do all the other parts, the sensation and motion with which they are endowed, with this difference, that the heart derives its power from every point of the spinal marrow, without exception, whilst every part of the body is only animated by a portion of that medulla (by that by which it is supplied with nerves); a difference which may serve to explain the intensity of the power of the heart, and its uninterrupted continuance from the moment of conception, till the hour of death.
>
> "From the great sympathetic nerve, the heart receives its principal nervous filaments; and it is only through that nerve that it can receive its energy from every part of the spinal marrow. The great sympathetic must, therefore, have its origin in this medulla.
>
> "From the same principle, we can no longer admit the assertion of Bichat, though pretty generally adopted, that there is in the same individual two distinct lives, one animal, the other organic; that the brain is the only centre of animal life; and that the heart, independent of the brain, and of the nervous power, is the centre of life.
>
> "It must, however, be observed, that there is a real and very important distinction to be made between the organs that receive their nerves from the great sympathetic, and those which receive theirs immediately from the medulla oblongata and spinal marrow.
>
> "The former receive their principle of action from the whole nervous power; their functions are not submitted to the will; they are exercised in every instant of life, and, at most, suffer only remissions.
>
> "The latter, on the contrary, have their principle of action in a limited portion of the nervous power; their functions are submitted to the will; they are temporary, and can only be repeated after complete intermissions of longer or shorter duration.
>
> "This distinction comprises nearly the same organs as that of the two lives; but it is evident that it rests upon a basis entirely different, since the organs of organic life, which, in the system of the two lives, is considered as independent of the brain and of the spinal marrow, are precisely those which receive the most powerful influence from it.
>
> "Numerous anatomical, physiological, and pathological facts can only be conceived and accounted for by this distinction. For instance, it is known that certain pains in the bowels cause debility, prostration of strength, and great disorder throughout the animal economy. This fact, which is unaccountable in the system of the two lives, is readily understood, from the moment we reflect that the intestines derive their principle of action from all parts of the nervous power, through the great sympathetic, from which they receive their nerves; and that consequently, their affections ought to react immediately upon every part of this same power.
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> "Experiments on the Principle of Life, and particularly on the Principle of the Motions of the Heart, and of the

seat of the principle," by M. Le Gallois, M. D. P. Translated by N. C. and J. G. Nancrede, M. D., Philadelphia, 1813, pp. 142–145.

Mr. William Clift, from a series of experiments upon the brain, spinal cord and heart of the Carp. (Philosophical Trans., 1815, pp. 91–96), similar to those performed by M. Le Gallois, drew the following conclusions:

1. That the muscles of the body of a Carp, four hours after the brain and heart are removed, can be thrown into powerful action.

2. That the moment that the spinal marrow is destroyed, the muscles lose all power of action.

3. That when water is admitted into the pericardium, and the fish allowed to swim about, the action of the heart ceases sooner than when the organ is exposed to the air, and the fish kept quiet.

4. That whether the heart is exposed or not, its action continues long after the spinal marrow and brain are destroyed, and still longer when the brain is removed without injury to its substance.

5. That the action of the heart is accelerated for a few beats by exposure of that organ; by exposure of the brain; injury of the brain; destruction of the spinal marrow, while connected with the brain; by the connection between the brain and spinal marrow being cut off; while removing the whole brain produces no sensible effect upon the heart's action, and destroying the spinal marrow after it is separated from the brain, renders the action of the heart slower by a few beats.

Up to the time of Haller, the opinion prevailed, that the muscles derive their power from the nervous system. Haller, on the contrary, taught that the power of the muscles depends on their mechanism; that the nervous influence is merely a stimulus which calls it into action, and consequently those muscles, the heart, for example, which act apparently only by the application of one peculiar stimulus, unconnected with the nervous system, are wholly independent of it. This opinion seemed confirmed by its being generally admitted, that the action of the heart continues after its removal from the body, and that it cannot be influenced by stimulating the brain or spinal marrow, or the nerves which terminate in it. Haller and his followers maintained that there were two distinct vital powers, one of the nerves, and another of the blood-vessel system. Certain objections, however, were raised against the doctrine of Haller, such as, that the heart is influenced by affections of the mind and disturbances of the cerebro-spinal system, and that it is supplied with nerves. Various hypotheses were formed to remove these difficulties. Several writers maintained, that although the heart is independent of the brain and spinal marrow, it may be subject to some peculiar action of its own nerves; others, that the ganglia through which its nerves pass, have a power independent of the sensorium commune. Fontana and others maintained that the nerves of the heart are useless: others, that the nerves are distributed in its vessels, and do not enter the substance of the heart: Scarpa, however, proved that the nerves are distributed to the heart, in the same way as to similar parts. The experiments of Le Gallois tended to establish the absolute dependence of the heart upon the force derived from the cerebro-spinal system, and more especially from the spinal marrow.

Dr. A. P. Wilson Philip* of Worcester, England, instituted in 1815, an important series of experiments, similar to those of Le Gallois, which while confirming the important result that the spinal marrow is capable of performing its functions independently of the brain, tended to overthrow the conclusion of Le Gallois, "that by the destruction of the whole or cervical part of the spinal marrow, the action of the heart is immediately so debilitated, that it is no longer capable of supporting the circulation: while by the destruction of the brain, on the contrary, its action is unimpaired: from which he inferred, that it is from the spinal marrow, that the heart derives the principle of its life and of its motions." M. Le Gallois considered those motions of the heart which remain after the destruction of the spinal marrow, or the interruption of the nervous influence upon the heart in any other way, and which in his opinion misled Haller and his followers, as movements without force, incapable of supporting the circulation, and analogous to the motions of other irritable parts on the application of a stimulus, which in this case is the arterial blood contained in the heart.

The following experiments will illustrate the mode in which Dr. Wilson Philip, successfully combatted the views advanced by Le Gallois.

A rabbit was deprived of sensation and voluntary power by a stroke on the occiput. When a rabbit is killed in this way, the respiration immediately ceases; but the action of the heart and of the circulation continue, and may be supported for a considerable length of time, by artificial respiration, as practiced first by Fontana, and afterwards by [illegible] Brodie, M. Le Gallois, and others. In the present experiment, the circulation was supported by artificial respiration. The spinal marrow was laid bare, from the occiput to the beginning of the dorsal vertebræ. The chest was then opened and the heart found beating regularly, and with considerable force. The spinal marrow as far as it had been laid bare, was now wholly removed, but without in the least affecting the action of the heart. After this, the artificial respiration being frequently discontinued, Dr. Wilson Philip, repeatedly saw the action of the heart become languid, and increase on renewing it. The skull was then opened, and the whole of the brain removed, so that no part of the nervous system remained above the dorsal vertebræ, but without any abatement of the action of the heart, which still continued to be more or less powerful, as the artificial respiration was discontinued or renewed. This being for a considerable time discontinued, the ventricle ceased to beat about half an hour after the removal of the brain. On renewing the respiration however, the action of the ventricles was restored. The respiration was again discontinued and renewed with the same effects.

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* Experiments made with a view to ascertain the principle on which the action of the heart depends, and the relation which subsists between that organ and the nervous system. Philosophical Transactions, 1815, p. 65–90.

In other experiments in which opium and other poisons were applied to the exposed brain and spinal marrow, and in others still, in which the sudden and complete destruction of the brain and spinal marrow, were effected by hot rods of iron, the action of the heart was not arrested, if artificial respiration was maintained.

From various trials, Dr. Wilson Philip, found that the circulation ceases quite as soon with, as without the destruction of the spinal marrow. Loss of blood seemed to be the chief cause of arrest of the circulation.

Dr. Wilson Philip, found however, that certain applications, to the exposed brain and spinal marrow, as spirit of wine, tintcture of opium and tobacco, caused an acceleration of the action of the heart. Dr. Philip attributed this increase in the number and force of the heart beats, to the transmission of the excitement, from the nervous centres of the brain and spinal cord to the central organ of circulation. But the fact that in the series of experiments, the same results followed, wherever the stimulus was applied, whether to the brain, the cervical, dorsal or lumbar portions of the spinal cord, would rather lead to the conclusion, that the spirit of wine, and solutions of opium and tobacco, were absorbed, and entering the blood acted as direct stimulants upon the ganglia and muscular fibres of the heart. Dr. Wilson Philip, concluded from these experiments, that the peristaltic motion of the intestines, obeys the same laws as the action of the heart.

According to this observer, his first set of experiments proved that the power of the heart, is independent of the brain and spinal marrow, for it continues to perform its functions after they are destroyed or removed, and the removal is not attended with any immediate effect upon its motions; the second set proved, that the action of the heart may be influenced by agents applied to any considerable portion, either of the brain or spinal marrow.

From another series of experiments, Dr. Philip concluded, "That the nervous influence, so far from having a power of preserving the excitability of the muscles, exhausts it like other stimuli." The excitability therefore is a property of the muscle itself.

By these experiments, Dr. Wilson Philip, arrived at the conclusion of Haller, that the heart and other muscles possess an excitability independent of the nervous system; but he was carried a step farther, that they are all equally capable of being stimulated through this system, by which, the great objections to Haller's doctrine are removed. His views are still farther sustained by certain erperiments which showed that if either the brain or spinal marrow be instantly crushed, the heart immediately feels the shock, the action of the heart and circulation becoming very feeble for a time, but, if artificial respiration be continued, the organ gradually regains its lost power; "precisely as a muscle of voluntary motion, will by rest recover its excitability, although all its nerves are divided, if its circulation continues."

Dr. Wilson Philip,* subsequently performed various experiments, illustrating the effects of division of the eighth pair of nerves, upon the functions of the lungs and stomach: and he found from repeated trials, that both the oppressed breathing and the collection of phlegm, caused by this operation, may be prevented by sending a stream of galvanism through the lungs: and he was thus led to the successful application of *galvanism* in the treatment of habitual asthma. Soon after the operation, the animal begins to breathe with difficulty, and this sympton gradually increases, and is at length evidently the cause of death. On inspecting the lungs after death, the air cells and tubes, as far as they can still be traced, are found filled with a viscid fluid; and in a considerable proportion of the lungs, generally more or less according to the time the animal has survived the operation, every trace of both tubes and cells is obliterated, the lungs both in color and consistence, assuming much the appearance of liver. The portions of lungs thus changed, sink in water. Dr. Wilson Philip ascertained by repeated experiments, performed in the presence of various gentlemen, that after the nerves supplying the lungs are divided and the ends separated, if the proper degree of *Voltaic* electricity was transmitted continuously through the lungs, by those portions of the nerves, which remained attached to them, no affection of the breathing supervened, and the lungs after death were found quite healthy, provided that the current of electricity had been properly applied. When the electrical current was too powerful, or has continued for such a length of time as to excite inflammation, the appearances were entirely different from those produced by simple division, without the galvanic current. In the same manner it was found that when the nerves supplying the stomach were divided, digestion was altered and finally arrested; but when the electrical and galvanic current of proper intensity was passed through the nerves attached to the stomach, digestion was performed as in a healthy organ.

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* On the effects of Galvanism in Restoring the due action of the Lungs. Phil. Trans., 1817, pp. 22–31. An Experimental Inquiry into the Laws of the Vital Functions, etc. Philadelphia, 1818.

Some positions, respecting the influence of the Voltaic Battery, in obviating the effects of division of the Eighth Pair of Nerves. Phil. Trans., 1822, pp. 22–23.

Some observations on the effects of dividing the nerves of the lungs, and subjecting the latter to the influence of Voltaic electricity. Phil. Trans., 1827, pp. 297–300.

Some observations relating to the Function of Digestion. Phil. Trans., part 1, 1829, p. 137. Some observations on the Functions of the Nervous System, and the relation which they bear to the other vital functions. Phil. Trans., part II, 1829, p. 261. On the Nature of Sleep. Phil. Trans., 1833, p. 73. On the Relation which subsists between the Nervous and Muscular Systems in the more perfect animals, and the nature of the influence by which it is maintained. Phil. Trans., 1833, pp. 54–73. On the Nature of Death. Phil. Trans., 1834, p. 167. On the Sources and Nature of the Powers on which the Circulation of the Blood depends. Phil. Trans., 1831, p. 489.

From such experiments Dr. Wilson Philip concluded, "that the effects of dividing the nerves of a vital organ, and separating the divided ends, is not merely that of deranging its secreting power, but *all those powers on which its healthy structure depends; and that the effect of Voltaic electricity, is that of preserving all these powers.* * *

The nervous power is essential to the functions of secretion, and the other assimilating processes of the animal body; and that Voltaic electricity applied in the same way, as far as possible, is capable of supplying its force in these processes." Phil. Trans., 1827, p. 300.

By a series of experiments, Dr. Wilson Philip demonstrated that the circulation in the capillary vessels is independent of the heart; and that the vessels bore the same relation to the nervous system, that the heart does, "their power being independent of this system, but equally with the heart capable of being influenced by either stimulants or sedatives applied either to the brain or spinal marrow, and that even to the instantaneous destruction of their power. They in all respects bear the same relation to the nervous system with the heart, which affords the strongest argument for believing that their power is of the same nature. The circulation is maintained by the combined power of the heart and blood vessels: and the power of both, is a muscular power." Phil. Trans. 1831, pp. 489-496.

For the purpose of determining whether the action of the heart is affected by impressions made upon the ganglia of the sympathetic system, Dr. Wilson Philip caused the performance of the following experiment:

"Mr. Field partially divided the spinal marrow near the head in an ass, in such a manner as to destroy the sensibility, as far as the experiment was concerned, but not to interrupt the respiration, thus bringing the animal into the best possible state for the experiments. It lay as still, and suffered as little during it, as an animal quite dead in the usual sense of the word, while the circulation was more perfect than it could be under any artificial inflation of the lungs. In another respect, the state of the animal was particularly favorable, for Mr. Field succeeded in exposing the semilunar ganglion and its plexuses with a very trifling loss of blood, not, I believe, four ounces. The heart was then found to pulsate sixteen times in ten seconds, as ascertained by the pulsation of the arteries in the neighborhood of the ganglion. The ganglion and the plexuses were then irritated by the point of a scalpel, and at length cut across in various directions; but, although, the beats of the heart were repeatedly counted during these operations, they continued uniformly of the same frequency. Spirit of wine was then applied to the wounded ganglion and plexuses, but without the least change in the beats of the heart. A strong infusion of tobacco in water was now applied, but with the same result, the beatings of the heart being still sixteen in ten seconds; nor could any variation in the force of the beats be observed in any part of the experiment.

"The conclusion was drawn from the experiment, that we cannot influence the organs supplied by the ganglionic nerves by causes affecting the ganglions and plexuses, independently of the brain and spinal marrow; and the inferences from this and the preceding facts are unavoidable, that the former organs make only part of the channel through which the influence of the latter is conveyed; and that the peculiar office of the ganglions and plexuses is to combine the influence of the nerves which terminate and are blended in them, and send off nerves endowed with their combined influence, in consequence of which the parts which receive the nerves proceeding from them, become subject to every part of the brain and spinal marrow." Phil. Tran., 1833, p. 61.

Dr. Wilson Philip thus recapitulates the more important results, which had been established by his experiments and researches, which had been proscuted for near thirty years:

"That the power of the muscles both of voluntary and involuntary motion is independent of the nervous system; but that both are subjected to its influence, this influence being the constant stimulant in the functions of the former, but only an occasional stimulant in those of the latter, which, in their ordinary functions are excited by stimulants peculiar to themselves.

"That to the muscles of voluntary motion it is supplied from those parts of the brain and spinal marrow, from which the nerve of the particular muscle takes its rise; to each of the muscles of involuntary motion, from every part both of the brain and spinal marrow.

"That these organs are the only active parts of the nervous system, and that the cerebral and spinal nerves on the one hand and the ganglionic nerves with their ganglions and plexuses on the other, are only the channels through which their influence is conveyed, the power of both systems of nerves being at all times proportioned to the excitement of the brain and spinal marrow, and soon ceasing, and not to be revived when their influence is withdrawn, and being uninfluenced by causes acting independently of these organs on either set of the nerves themselves or on the ganglions and plexuses.

"That the ganglionic system of nerves, with their ganglions and plexuses, is the means of combining the influence of every part of the brain and spinal marrow, and bestowing it on the muscles of involuntary motion, as well as on the various secreting and other assimilating organs, these muscles being subservient to the functions of these organs, which it appears, from direct experiment, require for their due performance the combined influence of every part of the brain and spinal marrow.

"That the manner in which the nervous influence affects the muscular fibre is not essentially different from that in which it is affected by other stimulants and sedatives.

"That this influence is not an agent peculiar to the nervous system, but capable of existing elsewhere, and consequently not a vital power properly so called, which further appears from an agent which operates in inanimate nature being capable of all its functions.

"That the brain and spinal marrow therefore, so far from bestowing on the muscular fibre, its power, only supply an inanimate agent which like all other such agents, capable of affecting it, acts on it either as a stimulant or sedative, according to the degree in which it is applied; and that the whole of the facts relating to this agent, proves its identity with Voltaic electricity which has been found experimentally to be capable of all its functions.

"We cannot review the phenomena of the animal economy without being struck with the extent and variety of the nervous influence. We not only find the intercourse between the animal and the external world maintained by it, the heart and vessels subjected to its control, and secretion and the other assimilating processes immediately dependent on it, but that by its means the animal body is formed into a whole, every part of it being capable of influencing every other." Phil. Trans., 1833, p. 70.

During more than a hundred years, the import of the numerous branches connecting the sympathetic with the cerebral and spinal nerves, has been made the subject of a number of conflicting theories. Many physiologists with Haller and his school, have supposed that the primitive fibres contained in their connecting cords arise from the cerebro-spinal nerves, pass through the ganglion, and subsequently radiate into its branches. According to this view the sympathetic is essentially a cerebro-spinal nerve;—presided over by the brain and spinal cord, just as the peripheric organs are by the other nerves. Hence, the physilogical peculiarities of its branches, would depend solely on the numerous ganglia that are interposed in their course. Other physiologists have followed the theory started by Petit, and developed by Bichat, according to which the sympathetic or ganglionic system constitutes a nervous system independent of the brain and spinal cord, its peculiar fibres supplying the intestines, the blood-vessels, the glands, and in general terms—all those tissues, which are destined to subserve the phenomena of nutrition, and the unconscious and involuntary functions. According to this theory, the sympathetic is a special visceral, vegetative, or organic nervous system; which has an authority independent of, and co-equal with its animal counterpart, composed of the cerebro-spinal nerves, which effect the conscious feelings of sensation and pain, and the voluntary movement. This question has been examined anatomically, physiologically and pathologically by Prof. John Fred. Lobstein, who appears to have anticipated many of the results of recent experiments and research, and advanced doctrines which have since been claimed as original by others.

The following quotations from the elaborate work of Lobstein upon the *Structure, Function, and Diseases of the Sympathetic Nerve* embody the most important results and generalizations established by this author, and illustrate in a forcible manner the relations between the cerebro-spinal and sympathetic systems. The author sums up in the following manner the theories of Reil and others:—

"The cerebral nervous system is formed differently from that of the sympathetic system. The branches of the former converge from the periphery of the body towards the cerebrum, and are inserted into it by their roots, as the roots of vegetables are in the soil; that system, therefore, has but one centre, which is in the encephalon. The latter, on the contrary, is not collected into any centre; it has no focus of action, but exercises its functions over a wide surface.

"The sympathetic system connects the organs together in three different modes: 1. It forms networks around the vessels, which embrace the arteries with their slender and minute branchlets (as the ivy clasps the stem of a tree), and penetrates with them to the organs. These networks are known under the name of plexuses, twelve of which are enumerated, appertaining to different parts. * * 2. These plexuses are connected to the brain and medulla spinalis by branches which Reil calls conductors. * * 3. These branches, the conductors of the plexuses, appear to form a perfect connection between the animal and vegetable systems; every commotion which the lower viscera suffer would be conveyed to the sensorium commune, and *vise-versa*—the will would exercise a perfect control over the organs of the thorax and abdomen, were not these movements intercepted by enlargements in the conductors called ganglia."—pp. 72, 73.

"When the two nervous systems by which the animal is rendered more perfect are considered physiologically, each may be esteemed a sphere of activity in which the vital actions are differently performed. In the animal sphere, (that is, in the cerebrum, the medulla spinalis, and their nerves), the determination of the will and senses, when transferred to the common sensorium, become impressions instanter, and, as it were, at a single impulse. In the vegetative sphere, the nervous energy is slowly, steadily, but obscurely dispersed into the organs. These are connected together, act according to their peculiar laws, and compose a system separate from the animal sphere, over which appropriate laws preside. This system also possesses the faculty of perception—namely, it receives impressions, and reacts upon them; but this perception abides in its own region, and is not communicated to the brain. In a healthy state, the system of ganglia exerts no manifold influence upon the cerebral system, from which it is divided by the separatory or isolating apparatus, the series of ganglia in the sympathetic nerve. But the case is different in a state of disease, for when the vital energy is increased in the communicating nerves of the plexuses, the condition of the ganglia is changed; they transmit impressions which the extremities of the nerves in the viscera receive, and become conductors, whilst before they were non-conductors or isolators." * * pp. 74, 75.

"In the fœtus, none but the sympathetic nerve is in vigorous action; it exists previous to the secretory and nutrient organs; it sustains the energy of the heart; and breaks in sometimes upon the cerebral sphere, and determines those automatic motions which the infant, when closed in the uterus, performs with its muscles. Acephalous fœtuses, destitute of cerebral and spinal medulla, and hence wanting the nervous centre from which emanates the principle of muscular contractions, perform, nevertheless, muscular movements which can be in no other way excited than by the vital influence of the sympathetic nerve, which is joined by an anastomosis with the spinal nerves."—p. 77.

"During the extra-uterine life of man, when there exists some immediate internal sense inherent to the stomach, this nerve forms a remarkable intercourse between the cerebrum and the viscera of the thorax and abdomen, as is proved by numberless phenomena. Then, as in the embryo and fœtus, it governs the system of capillary vessels, and directs the functions of assimilation and nutrition, through the influence of the vital plastic power, which Broussais calls vital chemistry." * * p. 77.

After this general statement of the facts established, and theories broached by others, Lobstein proceeds to give the results of his own investigations:

"According to a corollary of the greatest importance, there exists a relation between the sympathetic nerve and the par vagum—to-wit, that one may take upon it the functions of the other; for in the inferior vertebrated animals the par vagum appears to be more prolific in branches distributed to the intestines, as the sympathetic nerve is less;

the nerves supplying the lungs are divided and the ends separated, if the proper degree of *Voltaic* electricity was transmitted continuously through the lungs, by those portions of the nerves, which remained attached to them, no affection of the breathing supervened, and the lungs after death were found quite healthy, provided that the current of electricity had been properly applied. When the electrical current was too powerful, or has continued for such a length of time as to excite inflammation, the appearances were entirely different from those produced by simple division, without the galvanic current. In the same manner it was found that when the nerves supplying the stomach were divided, digestion was altered and finallly arrested: but when the electrical and galvanic current of proper intensity was passed through the nerves attached to the stomach, digestion was performed as in a healthy organ.

From such experiments Dr. Wilson Philip concluded, "that the effects of dividing the nerves of a vital organ, and separating the divided ends, is not merely that of deranging its secreting power, but *all those powers on which its healthy structure depends; and that the effect of Voltaic electricity, is that of preserving all these powers.* * *

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"The cerebral nervous system is formed differently from that of the sympathetic system. The branches of the former converge from the periphery of the body towards the cerebrum, and are inserted into it by their roots, as the roots of vegetables are in the soil; that system, therefore, has but one centre, which is in the encephalon. The latter, on the contrary, is not collected into any centre; it has no focus of action, but exercises its functions over a wide surface.

"The sympathetic system connects the organs together in three different modes: 1. It forms networks around the vessels, which embrace the arteries with their slender and minute branchlets (as the ivy clasps the stem of a tree), and penetrates with them to the organs. These networks are known under the name of plexuses, twelve of which are enumerated, appertaining to different parts. * * 2. These plexuses are connected to the brain and medulla spinalis by branches which Reil calls conductors. * * 3. These branches, the conductors of the plexuses, appear to form a perfect connection between the animal and vegetable systems; every commotion which the lower viscera suffer would be conveyed to the sensorium commune, and *vice-versa*—the will would exercise a perfect control over the organs of the thorax and abdomen, were not these movements intercepted by enlargements in the conductors called ganglia."—pp. 72, 73.

"When the two nervous systems by which the animal is rendered more perfect are considered physiologically, each may be esteemed a sphere of activity in which the vital actions are differently performed. In the animal sphere, (that is, in the cerebrum, the medulla spinalis, and their nerves), the determination of the will and senses, when transferred to the common sensorium, become impressions instanter, and, as it were, at a single impulse. In the vegetative sphere, the nervous energy is slowly, steadily, but obscurely dispersed into the organs. These are connected together, act according to their peculiar laws, and compose a system separate from the animal sphere, over which appropriate laws preside. This system also possesses the faculty of perception—namely, it receives impressions, and reacts upon them; but this perception abides in its own region, and is not communicated to the brain. In a healthy state, the system of ganglia exerts no manifold influence upon the cerebral system, from which it is divided by the separatory or isolating apparatus, the series of ganglia in the sympathetic nerve. But the case is different in a state of disease, for when the vital energy is increased in the communicating nerves of the plexuses, the condition of the ganglia is changed; they transmit impressions which the extremities of the nerves in the viscera receive, and become conductors, whilst before they were non-conductors or isolators." * * pp. 74, 75.

"In the fœtus, none but the sympathetic nerve is in vigorous action; it exists previous to the secretory and nutrient organs; it sustains the energy of the heart; and breaks in sometimes upon the cerebral sphere, and determines those automatic motions which the infant, when closed in the uterus, performs with its muscles. Acephalous fœtuses, destitute of cerebral and spinal medulla, and hence wanting the nervous centre from which emanates the principle of muscular contractions, perform, nevertheless, muscular movements which can be in no other way excited than by the vital influence of the sympathetic nerve, which is joined by an anastomosis with the spinal nerves."—p. 77.

"During the extra-uterine life of man, when there exists some immediate internal sense inherent to the stomach, this nerve forms a remarkable intercourse between the cerebrum and the viscera of the thorax and abdomen, as is proved by numberless phenomena. Then, as in the embryo and fœtus, it governs the system of capillary vessels, and directs the functions of assimilation and nutrition, through the influence of the vital plastic power, which Broussais calls vital chemistry." * * p. 77.

After this general statement of the facts established, and theories broached by others, Lobstein proceeds to give the results of his own investigations:

"According to a corollary of the greatest importance, there exists a relation between the sympathetic nerve and the par vagum—to-wit, that one may take upon it the functions of the other; for in the inferior vertebrated animals the par vagum appears to be more prolific in branches distributed to the intestines, as the sympathetic nerve is less;

by the mind, and *vice versa.* I shall allege some cases of abdominal disease in the third section of this work,
ch this sympathy is sufficiently manifest in the morbid state."—p. 98.
e route by which the descending or ascending impression goes and returns, is none other than the abdominal
or the abdomino-cephalic anastomotic branch. This alone, and uninterrupted by ganglia, forms the immediate
urse between the cerebrum and abdomen."—p. 99.
reflecting upon the nature of intermittent fevers, I have thought that it might, perhaps, be found in the
r and perverted action of the abdominal nervous system, and there appear, indeed, to be sufficient grounds to
this opinion probable." * *—p. 121.
e paroxysms of intermittent fever are tied down to a regular rhythmus, in consequence of their being radicated
nervous system, upon which nature has impressed a law, according to which they must perform their functions
ically."—pp. 121, 122.
ch nervous system, therefore, is obnoxious to its own diseases. But the mode in which the cerebral and spinal
, and the nerves of the abdominal plexuses and ganglia are affected by disease, is the same. As in the various
of convulsions, epilepsy, tetanus, etc., there is disorder in the voluntary nerves, even when no organic lesion can
overed in them; so the nerves of the thoracic and abdominal viscera may be affected without any alteration
tible to the senses. As the perverted action of the cephalic brain is reflected with great force upon the abdo-
brain, so in turn does the latter re-act upon and overwhelm the former; and finally as the cerebral system,
t is stupefied, as it were, by the violence of disease, destroys life, in like manner, I believe, an analogous
akes place in certain diseases in the solar plexus."—p. 122. Connection of the simpathetic and cerebro-spinal
s, illustrated by numerous pathological conditions. Effect of blow upon epigastrium, p. 122. Effects of the
on of miliary exanthemata in producing abdominal paralysis or apoplexy, hemicrania excited by hypochon-
d hysteria, p. 122. Relations of affections of the head to the state of the ganglionic system and the bowels, pp.
5. Explanation of delirium and of the action of cathartics in modifying the phenomena of fever, pp- 122,
"Sympathy between the teeth and abdominal nerves," p. 127.
*e perverted action of the brain is by no means circumscribed to the cavity of the cranium; it is extended to distant regions
body, whence organic diseases are produced.*
*er lesions of the brain there is undoubtedly a dynamic disorder of the nervous apparatus of the liver, antecedent to the
nation and suppuration of that organ. Various hypotheses have been invented to explain the connection between the brain
patic system, none of which have as yet been at all satisfactory. I may with better reason, refer it to a communication of
t par vagum with the solar plexus, by which the cerebrum is connected to the right semilunar ganglion, from whence
e directly the posterior nerves.*"—pp. 131, 132.
tein illustrated the relations of the sympathetic and cerebral system of nerves, and also the connection of the
s system with diseases, by numerous pathological facts. The notes added by Dr. Joseph Pancoast also contain
ting corroborative facts.
Treatise on the Structure, Functions, and Diseases of the Human Sympathetic Nerve," by John Fred. Lobstein.
ated from the Latin, with notes, by Joseph Pancoast, M. D., Philadelphia, 1831.

the *Third* (Pathological) *Section* of his work, Lobstein gives various observations, illus-
g the connection of certain fevers and inflammations, with diseased states of the sympa-
ganglia and nerves. Thus he attributes the oppression of the chest, shortness of breath,
ure of the præcordia, and sensation of anxiety which precede the appearance of the
ion in various diseases, as scarlatina and smallpox, to the action of the poison upon the
lionic system. He sustains the view that intermittent fevers are caused by the disorder
erverted action of the abdominal nervous system, on the following grounds: 1st. The
of this disease are very rare, in which the functions of the abdominal organs continue
ous and entirely unaffected. 2d. The commencement of the paroxysms is often marked
vomiting. 3d. We experience daily that this disease is mitigated, and very often en-
removed by the use of cathartics. 4th. A single emetic, when given previously, some-
suppresses the paroxysm, and not unusually removes the whole disease; from which it
rs that this remedy makes an impression upon the solar plexus, of an opposite nature to
which has produced the fever. 5th. When the disease is either maltreated, or left to
congestions are produced in the abdominal viscera, induration of the liver, intumescence
spleen, etc., and the general morbid state is changed into a topical affection. This
norphosis appears to prove that the morbid action prevails at first in all the plexuses, and
vards migrates from one to another. For it is first apparently disseminated in the whole
ory of the ganglionic system, before it runs with much impetus into a single plexus,
is commonly the splenic; and as the vessels are under the influence of the nerves, it
ot be otherwise than that congestions should be produced in the vessels. 6th. The
ysms of intermittent fever are tied down to a regular rythmus, in consequence of their
radicated in the nervous system, upon which nature has impressed a law, according to
they must perform their functions periodically. According, therefore, to Lobstein, the
id cause of intermittent apoplectic fevers (pernicious intermittent of Alibert), is seated in
anglionic system of the abdomen, for he found no mention made by authors of any
kable disorder of the cerebrum, as being the idiopathic cause of this disease. Although
been said that there is nothing in the affections of the sympathetic nerve to be detected
e senses, yet Lobstein affirmed that he was convinced, by attentive autopsic researches,
phlegmasiæ positively occur in that nerve, corresponding to various diseases; and he
ssed himself as fully convinced, that other organic changes might be found in this nerve,
cultivators of anatomy would sedulously investigate the subject. To Lobstein, should,
fore, be awarded the credit of having first directed the attention of the profession to the
tural alterations of the sympathetic, and their connection with diseased states of the
s, and of the general system. This was not a mere matter of conjecture, but his opinion
ased upon his own direct pathological observations. Thus, in a careful autopsy of a
ant woman, who died apparently from obstinate vomiting, distressing pain in the back,
apid emaciation, the stomach discharging black vomit towards the end of the disease, the

brain and organs, and the uterus, which was in the fifth month of pregnancy, and the fœtus which it contained, were found to be normal; the only lesions were observed in semilunar ganglia, which were intensely red and inflamed.

In the body of a girl six years of age, who had been seized with epidemic pertussis, which was first converted by metastasis into a spasmodic vomiting of three days' continuance, and finally degenerated into an incurable form of clonic convulsions from which she died, Lobstein found the whole left part of the solar plexus inflamed, whilst the right appeared to be in a natural condition. He also quotes the testimony of Autenrieth, the celebrated Professor at Tubingen, who, on examining the body of a girl who had died from pertussis, found the par vagum inflamed in the whole of its course through the thorax. The cardiac nerves and the thoracic portion of the sympathetic nerve, had likewise suffered some alteration. Professor Autenrieth also asserted that he had seen the abdominal nerves (sympathetic) a little changed *in subjects who had died from Typhus Fever.*

Dr. Aronssohu, an able surgeon of the Strasburg Hospital, communicated the history of two cases of disease, which plainly denoted the existence of inflammation of the semilunar ganglia. Death in the first case resulted from the removal of a fibro-cartilaginous tumor, loosely attached to the dorsal spine. The second case was that of a woman thirty-six years old, who, in her second pregnancy, was subjected to vomiting, which continued throughout the whole period of gestation, and after parturition, but was rendered milder by the appearance of a furfuraceous eruption upon the breast and arms. To these morbid symptoms were afterwards added inflammation and swelling of the left knee, and diarrhœa; but after the supervention of the latter, the vomiting which had been so obstinate and continual for almost three years, was brought to a close. Finally, hectic fever was developed, which, by exhausting the strength, gradually terminated life. On examination, after death, the villous coat of the stomach appeared to be inflamed, and thicker than usual, especially towards the pylorus, and the semilunar ganglia were found in a state of general inflammation.

In the body of a girl ten years of age, who had died from the retrocession of a miliary eruption attended with symptoms of great anxiety, oppression of the chest, and distention of the epigastrium, Lobstein found a place in the left trunk of the intercostal nerve highly inflamed between the eighth and tenth ribs, with a phlogosis of the ninth and tenth thoracic ganglia, and their two anastomatic branches from the costal nerve. Lobstein records also various alterations of the sympathetic nerve, in diseases of the lungs and heart, and gives instances to show that the sympathetic nerves have been enlarged in various diseases. Thus A. Duncan has noticed a case of diabetes, in which the urinary bladder was very much dilated, and the sympathetic nerve three or four times larger than usual from its ingress into the abdomen, and its termination in the pelvis.

Lobstein observed the nerves forming the suprarenal plexus, much thicker and enlarged in disease, where the renal capsules, which were more than twice as large as usual, had degenerated into tubercular substance. Lobstein proved, by observations undertaken for the purpose, that the nerves may not only be increased in thickness, but likewise in number, as in cases of hydrosarcocele, in the spermatic cord, organic disease of the epididymus, and hypertrophy of the thyroid gland; and he also showed that in certain diseased states, the reverse condition may exist, viz: decrease in the number and size of the nerves supplying the diseased organ.

The physiological and pathological relations of the sympathetic and cerebro-spinal nervous systems have also been subjects of investigation by the late Dr. Samuel Jackson, formerly Professor of the Institutes of Medicine in the University of Pennsylvania.

The following quotations from his work on the Principles of Medicine, published more than forty years ago, will show that his views were expressions of those relations of the nervous system, which are now being recognized by the profession:

> "Considerations, based on the anatomical structure, lead to the following inferences as to the functions of the ganglionic system:—
>
> *a.* "It is not independent of the cerebro-spinal nervous system, but derives its nervous activity from its connection with that system.
>
> *b.* "It is connected throughout its whole extent by the numerous nervous filaments passing from one ganglion to another, and uniting together the different plexuses.
>
> *c.* "The organs of the head, neck, thorax, and abdomen, with the genital organs, which receive nervous filaments from this system, are placed in a communion of actions and impressions, which are transmitted from one to the other, and it is thus the principal instrument of the sympathies between those organs.
>
> *d.* "Supplying the thoracic and abdominal viscera and genital organs with nerves, and communicating with the cerebro-spinal nervous system, it is the medium of communication between these organs and the nervous system of relation.
>
> *e.* "Supplying the abdominal and thoracic viscera and genital organs with numerous nerves, this system must be the chief agent in maintaining the exercise of their functions.
>
> *f.* "From the quantity of nerves which it distributes to the arteries, the closeness with which these vessels are invested with those nervous filaments, and which are lost in their coats, it must exercise an active agency over their circulation, and in this manner influence the secretions and nutrition.
>
> *g.* "The muscles that receive nervous filaments from this system have this peculiarity, that they act without volition or even consciousness. They must, consequently, receive the nervous stimulation for this purpose from the ganglionic system."—p. 37.

"From physiological and pathological facts we derive a confirmation of these principles, and obtain additional light in arriving at a knowledge of the functions of this system." * *—p. 37.

"The ganglionic system furnishing the principal nervous supply to the surfaces, where are seated the instinctive wants of the organism, we have in the above facts: 1st, that the ganglionic system is the nervous apparatus of the instincts and internal senses; 2d, that it communicates to the nervous system of animal life or relation the wants of the economy; and 3d, is capable of compelling that system to command the acts necessary to supply these wants.

"The interrogation of pathological phenomena will furnish additional elucidation to this subject.

"Irritations excited in the mucous tissue of the stomach and small intestines by the impressions of irritating agents, will excite irritations in the brain, and sometimes spinal marrow.

"The acute inflammations of the gastro-intestinal mucous tissue rarely, it may be asserted never, fail to occasion cerebral or spinal inflammation. Hence, they are invariably attended with headache and delirium, pains in the back, and often neuralgic pains in the extremities; they frequently occasion coma, apoplexy, hydrocephalus, convulsions, and paralysis. The chronic inflammations of the same tissue are also productive of chronic inflammations of the cerebral organs, and hence we find mania, monomania, catalepsy, and hysteria, are frequently connected with that state of the digestive organs. The connection between the cerebro-spinal organs and the mucous tissue of the stomach and small intestines, by which the actions of the one are transmitted to the other, is most probably effected through the nerves of the ganglionic system, and the inosculation of the solar plexus with the par vagum." * *—p. 40.

"None of the viscera that are placed under the influence of the ganglionic system of nerves, exercise so decisive and prominent an action over the cerebro-spinal nervous organs as the stomach and small intestines, especially the stomach.

"With less promptness and less constancy the other organs in this connection respond to the morbid irritation of the gastric mucous surface. An example is afforded in acute gastritis, in which the eye is always injected with blood, the fauces and tongue are arid and inflamed, the lungs often partake of the disorder, and respiration is impaired or deranged. The liver, the kidneys, the genital organs, all display more or less of disturbance in their functions, corresponding to the degree of the gastric disease. The acute irritation of these organs are attended, in a like mode, with disorder and disturbance of the stomach and its functions. Thus, inflammation of the kidneys, uterus, liver, and sometimes of the eye, is productive of an irritable state of the stomach, producing nausea and vomiting.

"The above pathological phenomena exhibit: first, a close connection between the stomach and the brain, by which they mutually reflect their irritatious on each other; and second, that the different organs to which the ganglionic system sends nerves, possess a free communion in their actions, which is most extensive and active between those organs most abundantly supplied with nerves.

"The ganglionic system, from these facts, would appear to be the medium of the sympathies that bind together the viscera of the splanchnic cavities—the cranium, thorax, abdomen and the genital organs." * * pp. 40–42.

"While it cannot be doubted that the organs of the moral faculties and passions are situated in the brain, neither can it be denied that the viscera are not entirely passive in their exercise.

"What is the exact part they perform, it is not easy to divine; but every one is conscious of sensations of a peculiar kind, having either a pleasurable or painful character, experienced in the epigastrium, in the chest, and sometimes in other parts, while under the influence of moral emotions of an agreeable or distressing nature.

"Sympathy is the medium connecting the organic actions of the different organs, and consists in the transmission to a remote organ, and the repetition in that organ, of the same mode of action which had been previously excited in some other organ. One organ is in this manner an excitor or stimulant to the actions of other organs, and concurs by this means to the maintenance of the vital activity of the whole organism." * * p. 590.

"In the senses, we have the positive demonstration of the transmission of impressions from one organ to another distant organ. * * A reciprocity and identity of action, it is apparent, prevails between the organs of the senses on the external surface, the recipients of external impressions, and the internal cerebral organs; an action excited in the one being transmitted to and repeated in the other. * * In this example of the senses we have presented a series of phenomena corresponding exactly with those constituting the sympathies, an action excited in one organ transmitted to and reiterated in another.

"Illustrations of a yet stronger character are furnished by the phenomena of the nervous apparatus, exemplifying in a more vivid light the character and mode of production of the sympathies.

"A mental impression, an idea, the excitation of a moral emotion, excites or modifies the movements of the capillary circulation, or disturbs the regular function of some important organ. The deep suffusion of the mantling blood in the face of the modest female, the eloquent language of the unuttered thought, is a striking exemplification of the influence of cerebral excitement over the capillary circulation. The effects of the passions on the heart, so frequently disturbed in its mode of action by moral emotions; the disorders of the biliary secretion, and derangement of the digestive action of the stomach, induced by profound mental operations, are strong evidences of the transport of impressions by the nervous system. A still more impressive example is found in the erotic ideas in dreams, so stimulating the genital organs as to provoke in them the actual sensations of the venereal act, and the ejaculation of the seminal liquor.

"In these examples is manifested an excitement transmitted by nervous communication from one organ, in which it is developed, to another organ, to which it is transported, and to which it is imparted." * * p. 592.

"The power of transmission is common to all the nervous apparatus, and is the means connecting its different portions. But for the transmission of the excitement of the organic actions a specific nervous apparatus is provided; it is the ganglionic system, or the sympathetic—the nervous system of the viscera and organic life. By the arrangement and distribution of this system a nervous appartus is provided, independent of, yet most intimately connected with the cerebro-spinal nervous system. It is endowed with the same force, nervous activity, fluid, or whatever name it may be known by. It possesses an analogous mechanism; nervous organs, or centres (the ganglia), nervous cords of communication or of transmission and receptive expansions in the viscera. Its actions and influences are in a similar mode—impressions received, excitement of nervous activity, and transmission of excitement; and it exercises a controlling and governing influence over all the splanchnic viscera, to which it is distributed, similar to that excited by the cerebro-spinal apparatus over the organs of locomotion, expression, sensation, the intellectual and moral faculties. * * pp. 592, 593.

"The two important centres which have been indicated as existing in the nervous system are immediately connected to each other, and by this connection the two apparatuses are placed in communication, and direct relations established between them. This communication is established by the eighth pair, par vagum, or pneumogastric. Arising from the medulla oblongata, it sends branches to the ganglia of the neck and thorax, but is principally expended in anastomoses with the solar plexus and semilunar ganglia; so that it may be either described as proceeding from these ganglia and terminating in the medulla oblongata, or, arising from this last, it terminates in the ganglia.

"The communication formed by the par vagum or pneumogastric between the centres—the medulla oblongata and semilunar ganglia—establishes the intimate relation and immediate connection uniting the two apparatuses of the nervous organs—the cerebro-spinal and ganglionic or organic. By this connection impressions are mutually reflected from the one apparatus into the other; and consequently the impressions of the viscera, especially those of the abdomen, which have no direct communication with the brain, reach that organ, while those viscera experience themselves modifications from the influence of cerebral excitement." * * —pp. 594, 595.

"In the natural state of the organism the correlation and mutual play of the organs on each other, through the medium of the nervous system, and by the radiation of its ingenerated nervous activity, are not characterized by features so striking as to be readily seized on and established. They nevertheless do exist, and are what is to be un-

[illegible]

The views of the eminent physiologist J. Müller concerning the Laws of Action of the sympathetic nerve and the propagation of impressions in it may be gathered from the following propositions [illegible] from the Second Edition of his Elements of Physiology.

[illegible] THE SYMPATHETIC [illegible] INVOLUNTARY MOTIONS.

The parts subject to the influence of the sympathetic nerve are incapable of voluntary motion.

The parts which are supplied with motor power by the sympathetic nerve still continue to move, though more feebly than before, when they are separated from their natural connection with the rest of the sympathetic system, and wholly removed from the body.

Hence all the parts endowed with motion and supplied with nerves from the sympathetic are in a certain degree independent of the brain and spinal cord.

The central organs of the nervous system can, however, exert an active influence on the sympathetic nerve and their motor power.

The experiments of Dr. Philip tend to show also, that distinct parts of the sympathetic, and the movements depending on them, those of the heart, for example, do not derive their [illegible] exclusively from distinct regions of the brain and spinal cord; but on the contrary, that the brain and the whole spinal cord, or every part of it, can exert an influence on the motions of the heart.

The movements excited in organs which are under the influence of the sympathetic [illegible] applied to them or to their nerves, are not transitory and momentary [illegible]; they are either enduring contractions, or they consist of a long-continued modification of the ordinary rythmic action of the organ: hence, in these organs, the reaction consequent on the irritation is decidedly of longer duration than the action of the stimulus. The motion of the nervous principle in the sympathetic nerve then is slow, and its rate [illegible] of being measured.

The immediate cause of the involuntary motions, and the cause of their type, lies [illegible] brain nor in the spinal cord, but in the sympathetic nerve itself: even the [illegible] the ganglia is not necessary: the branches of the sympathetic going to an organ [illegible] removed, the twigs distributed to the substance of the organ only being left, [illegible] will be continued as before, the reciprocal action between the muscular fibres [illegible] nervous twigs being apparently adequate to their production.

Although from the foregoing observations, it is certain that the extreme minute [illegible] sympathetic have still the power of regulating the movements of the parts [illegible] will, yet it is not less true that both the brain and spinal cord, and the ganglia [illegible] when in a state of irritation, exert an influence on these movements as long [illegible] organs are connected with them through the medium of the nerves. The [illegible] are however, also to be regarded as the source of the power of the [illegible] which would without them, become exhausted.

[illegible] from the facts already stated, that the sympathetic nerve is charged as it [illegible] power by the brain and spinal cord, which may be regarded as the sources [illegible] but that, when once charged, it continues to emit this influence in the [illegible] itself, even when the further supply is for a time diminished. This affords [illegible] of the phenomenon of sleep.

[illegible] narcotics locally applied to the sympathetic nerve does not extend to [illegible] the nerve supplies; but these organs may be paralysed by the direct [illegible] nervous fibrils which are distributed in them. In this respect the sympathetic [illegible] the cerebro-spinal nerves, which are deprived of their excitability by a narcotic [illegible] only in the part where it has actually touched them. But with reference to the [illegible] on the organs, under the influence of the sympathetic, there is observed in the [illegible] a remarkable, and at present inexplicable difference between the external and [illegible] of the organ. If a narcotic, such as pure opium, or extract of nux vomica [illegible] applied to the external surface of the heart, it produces little or no effect, or, at all events, a very slow one. The rythmic motions of the heart of the frog, removed from the body and thus treated [illegible] for a very long time; but if a small quantity of opium or extract of nux vomica be brought into contact with the inner wall of the ventricle, its movements are permanently arrested, frequently in a few seconds after the application. Of this fact, first observed by Dr. Henry, (Edinburgh, Med. and Surg. Jour., 1832,) Professor Müller, has satisfied himself by repeated experiments on frogs. This observation explains the rapidity of narcotic poisoning, when the poison has once entered the blood and reached the heart.

XI. The laws of reflexion, previously unfolded, prevail likewise in the actions of the sympathetic nerve; strong impressions on parts supplied by the sympathetic nerve may be propagated to the spinal cord, and give rise to motions of parts which derive their nerves from the cerebro-spinal system.

XII. Impressions on parts of which the nerves are derived from the sympathetic are communicated to the spinal cord and brain, and excite the motor influence of the sympathetic nerve by reflexion, although the reflex action is here less marked than in the case of the cerebro-spinal nerves. When we compare the reflex phenomena presented by the cerebro-spinal nerves, with those in which both the original excitation and reflected action are seated in parts under the influence of the sympathetic, we find that the former are much more energetic and readily excited than the latter: for how frequent, rapid, and easily indeed, are the reflex motions of coughing, sneezing, vomiting, etc., how much more numerous are the reflex phenomena in the cerebro-spinal system, compared with those presented by the organs governed by the sympathetic! The circumstance, also, that inflammations of the intestinal canal do not affect the pulse—that is the heart's action,—so quickly nor to so great a degree, as inflammation of other parts supplied with cerebro-spinal nerves, seems to favor the opinion that reflex motor action of the sympathetic nerve is less readily excited by irritation of the sympathetic itself than through the medium of the cerebro-spinal nerves; or rather perhaps, that circumstance is elucidated by the latter fact.

XIII. Reflected action of the sympathetic, from an impression communicated to the spinal cord by cerebro-spinal nerves, is a more frequent occurrence. As instances of this we may mention the effects on the heart's action of strong pleasurable or painful sensations of the skin; the movements of the iris from impressions on the optic, auditory and fifth nerves; and the contraction of the seminal vesicles from irritation of the sensitive nerves of the penis.

XIV. Can reflex phenomena be produced in the sympathetic nerve through the influence of the ganglia, and independently of the brain and spinal cord? This interesting question in the opinion of Professor Müller cannot at present be decided. If such a mode of reflex action existed, it would constitute a remarkable difference between the sympathetic and the cerebro-spinal nerves; it would show that the primitive fibres of the sympathetic are enabled by means of their ganglia to act on each other, which in the cerebro-spinal system never occurs, except through the medium of the brain and spinal cord. If muscles which derive their nerves from the cerebro-spinal system, and which are separated from the trunk of the body be irritated, neither the whole muscle, nor even the entire length of the muscular fibre, contracts, but merely the part directly affected by the irritation. The question is, therefore, whether on irritating a single point of the intestines removed from the living animal, together with the mesentery and ganglionic plexuses, contractions of some extent, as for example, in an entire loop of intestine, will take place. According to Professor Müller they will not; on the contrary, the irritated parts only will contract; indeed, on pinching the intestine with forceps, there does not even follow a circular contraction of the whole tube, but merely a limited contraction at the part pinched, while the opposite side of the canal remains quite flat and undisturbed. Volkmann obtained the same result from similar experiments. Henle obtained a different result, from that of the experiments of Müller and Volkmann, which seemed to prove that the reflex movements of the intestines can be excited only through the medium of the spinal cord. Even in intestines separated from the body of the animal, (a frog, rabbit or guinea-pig), he was able to excite circular contractions, which extended progressively in one or both directions, and sometimes were accompanied by contraction of the longitudinal muscular bands. Henle therefore, admits that the ganglia are centres of reflexion, which is also the opinion of Mr. Granger, (On the Spinal Cord, p. 133). Valentin, (De Function: Nervor, pp. 92–96), denies that the ganglia of the sympathetic can reflect the impressions of contripetal fibres upon centrifugal motor fibres, but he believes that they in some way render the centripetal fibres more prone to excite reflex motor action in the spinal cord. Reflex movements are excited, he says, with the greater facility, the more numerous the ganglia which the nervous fibres irritated, traverse in their course to the central organs. This latter observation would accord with the theory of the ganglia being centres of reflex action.

XV. We are at present entirely ignorant as to whether irritation can, through the medium of the sympathetic nerve, give rise to movements in another; since all the sympathetic phenomena of this kind can be explained on the principle of reflection from the brain and spinal cord.

XVI. It is not proved (and several facts have been observed which are opposed to the belief,) that the ganglia can exert an insulating action so as to impede the transmission of motor influence from the brain and spinal cord. It is not voluntary [illegible] generally, which is here referred to [illegible] the brain and spinal cord influences the whole sympathetic system. [illegible] a motion [illegible] after the heart's action and gives rise to [illegible] with borborygmi, and [illegible] in which the [illegible] are affected, [illegible] with a rumbling of air in the intestines.

[illegible] It is not certain that the ganglia are the cause of these [illegible] their nerves being withdrawn from the influence of the will.

[illegible] In certain organs which are subject to the influence of the [illegible] and of the spinal nerves at the same time, a voluntary influence seems to be exerted [illegible] the continuance of a [illegible] of sensitive impression.

[illegible] Many parts which are supplied by the sympathetic nerves are [illegible] voluntary motion only [illegible] associated with the motions of parts [illegible] a part of the voluntary motor influence being communicable [illegible] the associated motions of voluntary muscles.

[illegible] The motions of organs which derive their nerves from the sympathetic system are [illegible] peristaltic type. The motions are progressive in a certain direction, and [illegible] that this is dependent not merely upon the brain and spinal cord, but [illegible] the organs themselves.

OF THE SENSITIVE FUNCTIONS OF THE SYMPATHETIC NERVE.

The sensations of parts, the nerves of which belong to the sympathetic system, are [illegible] and undefined [illegible] sensations being excited in them only by [illegible] of irritation.

I. The sensitive impressions received by the sympathetic nerve, although conveyed to the spinal cord, may not be perceived by the sensorium, the organ of consciousness. The action of a sensitive nerve continued to the spinal cord may give rise to sensation, or [illegible] to produce a sensation it must be propagated with some degree of force to the brain [illegible] not produce sensation [illegible] confined to the spinal cord [illegible] by affecting the cord in other ways than sensation, namely, by reflex action.

II. The impressions which give rise to reflex motions when conveyed to the spinal cord by the sympathetic nerves are in most instances not productive of sensations, while those impressions which are received by cerebro-spinal nerves always give rise to sensations.

IV. The ganglia of the sympathetic nerve do not prevent the transmission of centripetal actions in that nerve to the spinal cord; they have not an insulating power over its nervous currents.

V. The ganglia are likewise not the cause of the impressions on the sympathetic nerve being unattended with true sensation.

VI. In many cases irritation of a violent nature in organs supplied by the sympathetic nerve gives rise to sensation in those parts; in other cases, the irritation being the same, the sensations in the parts affected are indistinct, while distinct sensations are present in other parts supplied with cerebro-spinal nerves.

VII. The secondary sensation in the cerebro-spinal nerves consequent on irritation of branches of the sympathetic [illegible] especially in the external parts of the organs affected.

VIII. That the ganglia exert a reflex action in the production of the sympathetic sensation is not proved, and many facts are opposed to the idea of their having such a function.

OF THE REFLEX FUNCTIONS OF THE SYMPATHETIC NERVE.

We are now [illegible] with the laws of the organic action of the sympathetic nerve; for we have but just seen that there are in all nerves, even in the cerebro-spinal, besides [illegible] organic fibres, on which depend the organic actions of the nerves, of secretion and of nutrition. We have now to enquire whether in these nerves the motions of [illegible] can be propagated only in the centrifugal direction from the brain and ganglia [illegible] or whether the action of the nervous principle [illegible] of communicating a vivifying influence [illegible] a reflex action [illegible] communicate the irritation of one gland to other organic nerves. [illegible] whether the organic nerves are, by virtue of their constituents, [illegible] secretion from a whole surface may be excited by [illegible] through the medium of the spinal cord. The facts [illegible] determined with certainty which is the [illegible] is more probable."

[illegible] secretions take place in distant [illegible] the medium of communication.

The [illegible] of the organic fibres or the ganglia or the roots of the sensitive nerves, [illegible] of the organic fibres to the spinal cord. The [illegible] of the spinal cord in the reflection motions is a de[illegible] of the different fibres in the ganglia of the sensitive nerves on each other [illegible] The cases of sympathetic affections of organic nerves [illegible] are very frequent. Impres[illegible] frequently give rise immediately to a general sweat, violent impressions on sensitive nerves are sometimes followed by syncope, and with a cold sweat. The latter phenomena are evidently the result of an influence reflected by the spinal cord, since the symptoms in syncope sometimes affect an extent of the system so great as to be explicable only in that way. In some other cases of this kind, it is more doubtful whether the phenomena may be explained in the same manner. Irritation of the conjuctiva of the eye and eye-lids, attended with sensations, gives rise to a flow of tears; stimuli applied directly to the mucus membrane of the nose, or volatile stimulants affecting the same mucus membrane, when taken into the mouth, producing violent sensations in the nose, likewise give rise to an effusion of tears. Mustard and horse-raddish have this effect sometimes even when taken in the mouth. It is usual to explain these phenomena by supposing the irritation to be communicated by the ethmoidal nerve to the trunk of the first division of the fifth nerve, and to be thence reflected upon the nervus lachrymalis: the secretion of tears from irritation of the conjunctiva has been explained in the same manner; the irritation of the conjunctiva being communicated to the first division of the fifth nerve, has been imagined to be thence again reflected upon the lachrymal branch; in both these cases however, the explanation is defective; for, inasmuch as the fibres of a cerebro-spinal nerve are wholly distinct in their entire extent, an impression on one portion of its fibres cannot be reflected upon others. Again, the same phenomena have been supposed to be the result of sympathy of the Schneiderian membrane with the lachrymal gland through the medium of the ganglion of the spheno-palatine, which has been stated by some anatomists to be connected with the ciliary ganglion by means of sympathetic fibres. Now, since the ciliary or lenticular ganglion, by its long roots, is connected with the nasal nerve, and thus with the trunk of the first division of the fifth, which gives off the lachrymal nerve, an immediate connection was thus found to exist between the spheno-palatine ganglion and the latter nerve. But the same objection must be made to this explanation as to the former; for, unless the fibres in the fifth nerve communicated with each other, an irritation conveyed through the ciliary ganglion and nasal nerve to the first division of the nervus trigeminus could not be reflected upon the lachrymal branch. There are other physiologists who imagine the impression in the nose to be communicated to the Gassérian ganglion on the trunk of the fifth nerve, and to be thence reflected upon the first division of the nerve and its lachrymal branch. No objection could be made to this explanation of the phenomena, provided that we knew that the Gasserian ganglion, the ganglion of a sensitive nerve, were capable of giving rise to sympathy and reflex action; if it were proved that centrifugal nervous currents can take place in sensitive nerves, such as the lachrymal nerve; and if it were demonstrated that the lachrymal nerve really supplies the lachrymal gland which regulates its secretion. Since the secretion of tears, like other secretions, is determined probably by fibres of the sympathetic nerve, the most simple explanation would still be that which supposes the irritation to be conveyed from the nose backwards to the spheno-palatine ganglion, and, by means of the connection of all the organic nerves with each other, to be reflected in some way or other through the medium of organic fibres upon the lachrymal gland. But whether such a reflex action from sensitive nerves directly upon organic nerves, without the intervention of the brain and spinal cord, can occur, is a questionable point; and I know no other argument in favor of its possibility than the impossibility of proving that it cannot occur. A very frequent instance of reflex action of the secreting function from irritation of a sensitive nerve is the increased flow of saliva often coming on quickly when food is taken into the mouth. The mode of explaining the phenomenon is equally as uncertain here as in the former case. The assumption that the brain and spinal cord form the medium by which the irritation of the sensitive nerve is enabled to excite the organic action is at least favored by the analogy of similar reflected actions of sensitive or motor nerves, through the intervention of the central organs."

II. There prevails a concert of action between the different parts of a secreting membrane; thus the state of one spot influences the condition of the whole extent of a serous membrane. Here it is more simple to explain the phenomena by communication of the organic fibres with each other.

III. A particular state of one organ, such as inflammation, or a secreting action in it, sometimes causes the production of a similar state in other parts. In this case we have an instance of reflected action of the organic fibres of one part upon those of another.

Inflammation of the testicle may be replaced by inflammation of the parotid; erysipelatous inflammation of the skin may be transferred to the membranes of the brain; suppression of the secretion of one organ may give rise to increased secretion in another. All such phenomena are probably attended with changes in the organic fibres belonging to the sympathetic system, which accompany the blood-vessels. And here, again, the question arises, whether such reflexions are produced through the medium of the sympathetic alone, or whether the brain and spinal cord are the medium of reflexion between the centripetal and centrifugal actions. There are no facts which enable us to decide this question; but in many cases it is probable that the sympathetic nerve alone is engaged in the production of the phenomena. In Mayer's experiments, ligature of the sympathetic nerve between the first and second cervical ganglia, was sometimes followed by an affection of parts which appear to be under the influence of the first cervical ganglion, namely, by inflammation of the eye. The peculiarity of the organic nerves, namely, the difficulty of distinguishing either origin or termination in them, their want of arrangement into trunks and branches, and the increase which they frequently undergo in their course, is certainly in favor of the possibility of their actions being popagated in all directions from the central points of the ganglia, and not confined to centripetal and centrifugal currents. This view is also favored by the circumstance, that when an organ ceases to be supplied with organic fibres from one source, the supply may be furnished by another. Ligature of an arterial trunk, without doubt injures the organic nerves which accompany it; nevertheless, no death of the part, atrophy, or cessation of secretion in it ensues; so that it appears as if the nerves accompanying the collateral vessels were able to supply the lost influence, or that the new supply is furnished by the organic fibres in the spinal nerves. On the other hand, the influence of the spinal nerves may be lost without atrophy ensuing. In V. Pommer's experiments, too, it was observed that division of the sympathetic nerve on both sides of the neck, gave rise to no injurious consequences, so, that perhaps the influence of the divided portions of the nerve had been supplied from other sources, as, for instance, by the fibres accompanying the vertebral arteries. The metastasis of a morbid process, however, takes place in all cases towards the organ which is predisposed to it; thus, in poisons, with tendency to pulmonic affections, the metastasis takes place from the skin to the lungs; in patients liable to hepatic disease, from the skin to the liver; and in others, with irritable bowels, from the skin to the intestinal canal, and so on. In considering the laws of equilibrium, to which the secretions are subject, not only the nervous system, but the nature of the different secretions, and their relations to the components of the blood, and to one another, are to be attended to.

IV. The ganglia appear to be the central parts from which the vegetative influence is distributed to the different organs. Inflammation of the eye and even the general phenomena of impaired nutrition, have been observed to follow injury of the first cervical ganglion.

V. This radiating influence of the ganglia appears to be in a certain degree independent of the brain and spinal cord, since the embryo may be developed while the brain and spinal marrow are destroyed.

VI. It appears, however, that the brain and spinal cord are the main source whence the power of the organic nerves is gradually renovated, since certain affections of the brain and spinal cord, attended with paralysis, are likewise productive of atrophy.—Elements of Physiology, Vol. 1, Sec. Ed., pp. 778-803, 1840–1842.

Professor J. Müller illustrated many of the preceding propositions by experiments, and he is entitled to the credit of having first systematically and philosophically applied the laws governing the action of cerebro-spinal nerves to the sympathetic. Even Magendie seemed to think that so little was known of the properties of the sympathetic, that he hesitated to regard it as a nerve. Müller not only applied the doctrine of reflex nervous action, as developed by Marshall Hall and himself, to the phenomena of secretion, nutrition and inflammation, and to the actions of the sympathetic or organic system of nerves, but he also accomplished much for Physiological and Pathological Science, in showing in a clear and philosophic manner how investigations on the subject must be prosecuted.

If the labors of Lobstein and Müller had been properly studied and recognized, there would have been no subsequent controversy as to the priority of discovery of the reflex actions of the sympathetic system and of the *so-called excito-secretory system of nerves.*

Dr. Henry F. Campbell, of Augusta, Georgia, published in June, 1850, "*An Essay on the Influence of Dentition in Producing Disease.*"[1] in which he endeavored to sustain, not by experiment, but by references to well known anatomical, physiological and pathological facts, and more especially by the experiments of Pourfour du Petit, Dupuy and J. Reid, on the sympathetic, the proposition

> "That in the anatomy and physiology, as well as in the dependent analysis of the process of dentition, we find ample ground for the opinion, that the diseases pertaining to this period, may be dependent, and in many instances are entirely so, upon the local irritation attending the process being transmitted through either the cerebro-spinal system of nerves, producing convulsive disease in the motory apparatus, or through the sympathetic, causing derangement in the secretory organs, particularly the alimentary canal, by the sway which it exercises over the arterial system from which these secretions are eliminated."

A similar theory was applied by Dr. Campbell, to Typhoid and Typhus fevers, in a paper presented to the American Medical Association at its session of May, 1853.[2] Thus he says:

> "After the most careful and laborious consideration of the phenomena, relationship and events of this truly mysterious disease, keeping in view at the same time as well as we were able, the *entire* physiological dependencies of such an intricate question, we are induced to regard the typhoidal state, manifested both in the typhoid and typhus fevers, as a morbid affection of the whole or portions of the ganglionic systems of nerves, known also as the great sympathetic nerve, but of the exact nature of which, and how produced, we know not."

Dr. Campbell admitted, however, that the preceding hypothesis rested upon no pathological observations of his own:

> "We are fully aware that our views of the pathology of typhoid fevers would be greatly corroborated, could there be discovered any appeciable *lesion* in the ganglionic nervous centres, in subjects who have died during their progress; but, like the pathological anatomy of all the nervous system, this would be an investigation attended with many difficulties. * * These changes, then, are probably molecular and inappreciable with our present means of investigation."

Dr. Campbell's views with reference to the reflex relation subsisting between the cerebro-spinal and sympathetic system of nerves, were farther expanded and illustrated by the more recent experiments of Claude Bernard and Brown-Séquard, in his "Prize Essay, The Excito-Secretory System of Nerves; its Relation to Physiology and Pathology,"[3] and in his elaborate Report on the Nervous System in Febrile Diseases, and the Classification of Fevers by the Nervous System.[4]

Dr. Marshall Hall published in the London Lancet, 1857, an article, in which he announced the discovery of a system or sub-system of *Excito-Secretory* Nerves, which he regarded as not less extensive than the Excito-Motory System of Nerves, which he had previously announced to the Royal Society, in February, 1837.

Dr. Campbell is certainly entitled to the credit of having first applied the term, Excito-Secretory, to the sympathetic nervous system; but neither Dr. Marshall Hall nor Dr. Henry F. Campbell demonstrated the reflex relation existing between the cerebro-spinal and sympathetic system of nerves.

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[1] Southern Medical and Surgical Journal, June, 1850, pp. 321–333.

[2] An Inquiry into the Nature of Typhoidal Fevers. Trans. Am. Med. Asso., May, 1853. Sympathetic Nerve in Reflex Phenomena. Trans. Am. Med. Asso., Vol. vi, 1853.

[3] Trans. Am. Med. Asso., 1857.

[4] Trans. Am. Med. Asso., 1858. Claim of Priority in the Discovery and Naming of the Excitory-Secretory System of Nerves, by H. J. Campbell. 1859.

EXPERIMENTS ON SECTION OF THE NERVES, ILLUSTRATING THE RELATIONS OF THE SYMPATHETIC TO NUTRITION, SECRETION, CIRCULATION, RESPIRATION AND ANIMAL TEMPERATURE.

The effects of section of the *par vagum* upon the conjunctival membrane of the eye, when practiced upon those animals where the sympathetic is so closely connected with this nerve, that the one cannot be divided without the other, have been noticed by various phyisologists. At a longer or shorter period after the trunks of the *par vagum* and the accompanying sympathetic nerves were divided, the conjunctiva became red, swollen, and projected over the cornea. The pupil was contracted, and only a small part of the ball of the eye was seen between the half closed eyelids. This inflammation frequently went on to the secretion of purulent matter, and after lasting some time began gradually to abate. Petit, as we have said, was the first who observed these effects upon the eye after the section of the *par vagum*, and justly attributed them to division of the trunk of the sympathetic; for he was perfectly aware of the connexion of this nerve with the sixth pair, and first branch of the fifth pair within the cavernous sinus, and of the intimate relation of the trunk of this nerve with that of the *par vagum* in the neck in quadrupeds. We have also shown that Cruikshank in like manner noticed this inflammation of the conjunctiva in his experiments upon the par vagum.

That Petit was right in supposing this inflammation of the eye to arise from section of the sympathetic and not of the *par vagum*, was fully demonstrated by the experiments of Dupuy, (Journal de Médécine, Chirurgie, etc., Decembre, 1816, tom. xxxvii, p. 340), upon the effects of the removal of the superior cervical ganglia of the sympathetic. These experiments of Dupuy were confirmed by those of Brachet (Functions du Systéme Nerveux, Ganglionaire, Chap. ix. 1830.)

This inflammation of the eye frequently takes place with great rapidity after section of the sympathetic; in one case Dr. John Reid observed the conjunctiva reddened a very few minutes after the operation; in two of Petit's experiments it is mentioned that in a quarter of an hour after the section of the nerves, the cartilaginous membrane at the inferior angle of the eye had encroached upon the cornea; and in the fourth experiment of Dupuy upon the horse, it is stated, "Aussitot après l'opération," the eyelids were swelled and the eyes watery. This inflammation appears to be confined to the conjunctiva—the contracted pupil and half closed eyelids probably depending upon the impatience of light generally accompanying this condition. Petit mentions that he killed a dog on the third day after the operation, and on dissection found the inflammation apparently restricted to the conjunctiva.

Dr. John Reid did not, however, consider it fairly ascertained that the inflammation is confined merely to the surface of the eye. In the experiments of Dupuy and Brachet upon the effects of the removal of the superior ganglion of the sympathetic, the same phenomena presented themselves as far as the eye was concerned, as when the *par vagum* is cut in the neck. Dr. John Reid held that this inflammation of the conjunctiva from section of the sympathetic in the neck, cannot, in all probability, be referred to the same cause as that produced by section or disease of the fifth pair—the former occurring almost instantaneously without arrestment of the usual secretion, and apparently from some direct effect upon the blood-vessels or their contents; the latter coming on more slowly, and apparently arising, as has been ingeniously suggested, from the arrestment of the usual secretions which protect the conjunctiva from the irritating effects of the external atmosphere, as seen in various cases when the nerves of secreting surfaces are cut. (Alison's Outlines of Physiology, p. 148. 1833).

Dr. John Reid,* who has enriched physiological science with several valuable memoirs† in which numerous experiments upon the nervous system are detailed; after having frequently verified the observations of Petit, Cruikshank, Dupuy, Brachet and others, carefully examined the question, whether after section of the sympathetic the contraction of the pupil and partial closure of the eyelids, might probably depend upon the impatience of light, which frequently accompanies inflammation of the conjunctiva. By a series of experiments performed during the summer of 1838, Dr. John Reid satisfied himself that the contraction of the pupil, the projection of the cartilaginous membrane or third eyelid situated at the inner angle of the eye, over the cornea, and the partial approximation of the eyelids to each other take place immediately after the injury of the sympathetic, and before the inflammation of the *conjunctiva* presents itself, and that they continue after it has disappeared. From the experiments of Dr. Reid, it would appear that in rabbits the superior ganglion of the sympathetic, and a considerable portion of the trunk of that nerve, as it lies in the neck, may be generally removed without affecting any change upon the iris: while the compression or section of the trunk of the sympathetic in the neck in dogs and cats, is instantly followed by contraction of the pupil, the forcing of the cartilaginous membrane over the inner part of the anterior surface of the eyeball, the retraction of the eyeball deeper into the socket, and a slight approximation of the eyelids. In dogs this also is followed—sometimes after a very few minutes, but generally after a longer interval, by inflammation of the *conjunctiva*, which is occasionally so severe that this membrane presents an almost uniform redness, and is covered by puriform mucus, and the cornea becomes dim. As far as Dr. Reid was able to observe this phenomenon the inflammation is confined to the *conjunctiva*. On the other hand, in the experiments which he made upon cats and rabbits, the inflammation of the *conjunctiva* in the former was trifling, if present at all: and in the latter it was entirely absent. Dr. Reid was at first inclined to believe that the outward projection of the third eyelid—for in the dog and cat it has no muscles attached to it—was dependent upon the rolling inwards of the eyeball: but subsequent observations nearly satisfied him that this depended upon the *retrahens oculi* muscle drawing the eyeball deeper into the orbit, by which the fat is pressed forwards, and the third eyelid pushed over the anterior surface of the eyeball. This would also explain the approximation of the eyelids. Dr. Reid found it impossible to give anything like a plausible explanation of the effects of injury of the sympathetic upon the eyeball and its appendages, and the cause of their dissimilarity in different animals: he regarded it as evident, however, that this is to be sought for in the connexion of the branches of the sympathetic with the encephalic nerves of the orbit, and especially with the sixth pair, and those branches forming the ciliary nerves. He expressed his intention of executing extensive minute dissections of the ascending branches of the superior sympathetic ganglion in various animals, to give some plausible solution of this question, and, if possible, to throw light upon the question, whether an injury of the cervical portion of the sympathetic in man, such as may occur in certain diseases and operations on the neck, would be followed by contractions of the iris, and inflammation of the conjunctiva.

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* On the Effects of Lesion of the Trunk of the Ganglionic System of Nerves in the Neck upon the Eyeball and its Appendages Edinburgh Medical and Surgical Journal, August, 1839.

† On the Relations between Muscular Contractility and the Nervous system—Ed. Monthly Journal Med. Science, May, 1841. Order of Succession in which the Vital Actions are arrested in Asphyxia—Ed. Medical and Surgical Journal, 1841. Effects of Venesection in renewing and increasing the Heart's Action, under certain circumstances—Ed. Medical and Surgical Journal, April, 1836. An experimental Investigation into the Functions of the Eighth Pair of Nerves, or the Glosso-Pharyngeal, Pneumo-Gastric, and Spinal Accessory—Ed. Medical and Surgical Journal, January, 1838, April, 1839. On some Points in the Anatomy of the Medulla Oblongata—Ed. Medical and Surgical Journal, January, 1841. On the Anatomical Relations of the Blood-Vessels of the Mother to those of the Fœtus in Human Species—Ed. Medical and Surgical Journal, No. 146, January, 1841. Injection of the Vessels of the Fœtus, to show some of the peculiarities of the Circulation—Ed. Medical and Surgical Journal, January and April, 1835. Sensational and Emotional Reflex Actions. On some Points in the Anatomy and Physiology of the Heart—Cyclopædia of Anatomy and Physiology. Tables of the Weights of some of the most Important Organs of the Body at different periods of Life—London Ed. Journal Medical Science, April, 1843. Observations on Phlebolites—Ed. Medical and Surgical Journal, April, 1835. Physiological, Anatomical and Pathological Researches, by John Reid, M. D., etc., Edinburgh, 1848.

In a case described in the Medical Gazette, (September 29th, 1838, p. 16, Vol. xxiii), when the right carotid, the vagus and the surrounding parts were described as being entirely enveloped in a large morbid tumor, and where, consequently, the sympathetic could hardly be supposed to escape, the pupil of that side was described as becoming smaller during the course of the disease.

During the late American civil war, after the battle of Fort Donelson, while in charge of a hospital steamer on the Ohio river, a case came under the observation of Professor J. S. Jewell,* M. D., of Chicago, in which there was a gun-shot wound in the left side of the neck, about two inches below the angle of the jaw, entering at the anterior edge of the sterno-mastoid muscle, and ranging backward and slightly inward, and issuing behind on the same side, close to the spinous process of the sixth cervical vertebra. At the time Dr. Jewell first saw the patient, and while under his observation, there was reddening of the corresponding side of the face, with a bluish tint, reddening, and watery condition of the eye on the same side, much heat, and a feeling of fullness and dizziness in the head, and swelling of, and discharge from the mucus membrane of the left nostril. From the direction the shot had taken, Dr. Jewell was certain that it had injured, if not divided both the sympathetic and pneumo-gastric nerves on the left side. Dr. Jewell also reports the case of a gentleman who came under his care, with severe erysipelas of the right side of the face and neck, complicated with marked malarial disorder. On the right side of the neck, midway between the lower jaw and clavicle, a large abscess was developed, which finally occupied all the space between the two points named. There was extensive sloughing and erosion of all subcutaneous structures, leading, finally to fatal hæmorrhage. But during the latter half of his illness, the phenomena, such as follow division or destruction of the sympathetic were developed: there was extreme redness of the corresponding side of the face and head; increased heat as compared with the other side: reddening of the eye; contraction of the pupil, etc. There was also at times, very irregular action of the heart. The patient died from hæmorrhage and blood poisoning (Chicago Journal of Nervous and Mental Disease, Vol. I. p. 15). Willebrandt, Gairdner, Coates, Ogle, Heineke, Verneuil, Eulenberg, Poiteau and others, have reported cases of compression of the sympathetic by means of tumors, aneurismal, glandular and otherwise.

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* Chicago Journal of Nervous and Mental Disease, Vol. I, No. 1, Jan., 1874, p. 14.

in which similar phenomena have been observed. Dr. William Ogle, (Medico. Chir. Trans., Vol. iii, p. 151), has reported an instance of probable destruction of the right cervical sympathetic by abscess, in which the eyeball was retracted, the palpebral fissure narrowed, the pupil contracted, the right side of the face redder and hotter than the left during repose, but after violent exercise or fever, colder; the left side of the face alone sweated, and the right side of the mouth and tongue were complained of as being dry. Dr. S. Weir Mitchell, in his recent valuable work on the *Injuries of Nerves*, Phila., 1872, pp. 318-321. (Also, Gunshot Wounds and Other Injuries of Nerves, 1864, pp. 39-44), gives the following as the only known cases of direct mechanical violence to the sympathetic nerve reported by the staff of the U. S. A. Hospital for injuries of Nerves, etc.

Wound of right sympathetic nerve ; wound healed in six weeks ; cerebral symptoms ; contracted pupil ; ptosis ; lachrymation, etc.

Edward Mooney, aged twenty-four ; wounded at Chancellorsville, May 3d, 1863 ; was standing erect, and looking towards the left side, when a ball entered his right neck, one and half inches behind the ramus of the jaw at the anterior edge of the sterno-cleido-mastoid muscle, passed across the neck, rising a little, and emerged immediately below, and a half inch in front of the angle of the jaw on the left side. He fell senseless, and may have remained so during half an hour. On awaking, he found his mouth full of clotted blood, which he pulled out; the bleeding had ceased. After a short rest he was able to walk nearly three miles to the rear, where his wounds were dressed with cold water. On his way he discovered that his speech had become hoarse, difficult and painful, and that deglutition gave rise to great uneasiness and to burning pains. * * After five days of great suffering and utter inability to swallow, he obtained some relief ; but for a month or more was forced to take a little water after every mouthful of food. The power to swallow gradually improved, and is now as good as it ever was. A week after he was wounded he was able to articulate without pain, although hoarsely. This difficulty also lessened by slow degrees. * * During his recovery, which was rapid the wounds healing within six weeks, he had a good deal of pain in the back of the neck. He says that he had headache, whenever, after the injury, he attempted to walk far, or exert himself. About one month after he was hurt, a comrade noticed the peculiar appearance of his right eye, and called his attention to it. A little later it began to be troublesome in bright lights, and has remained so ever since, with of late some change for the better.

July 15th, 1863.—Pupil of the right eye is very small, that of the left unusually large. There is a slight but very distinct ptosis of the right eye, and its outer angle appears as though it were dropped a little lower than the inner angle. The ball of the right eye looks smaller than that of the left. These appearances existed whether the eye was open or closed, and gave to that organ the look of being tilted out of the usual position. The conjunctiva of the right eye is somewhat redder than that of the left, and the pupil of the right eye is a little deformed, oval rather than round. * * The left eye waters a good deal, but has the better vision, the right eye having become myopic. In sunlight he sees well at first, but after a time, observes red flashes of light in the right eye, and finally, after long exposure, sees the same appearance with the left eye also. * * Has lost flesh and strength since he was wounded.

About August 30th, the patient rode to the office of Dr. Dyer, who examined his eyes with the opthalmoscope, but found no abnormal external appearances. Mooney walked from Dr. Dyer's office to the hospital, an unusual exertion, as he was weak, and avoided exercise, on account of the headache it caused. An orderly who was with him on this occasion, remarked to one of the hospital staff upon the singular appearance which his face presented after walking in the heat. It became distinctly flushed on the right side, and pale on the left. This fact was afterwards observed anew by one of us. The patient had used exercise and had just come in. The right half of the face was very red. The flush extended to the middle line, but was less definite as to its limit on the chin and lips than above these points. He complained of pain over the right eye, and red flashes in that organ.

A careful thermometric examination, made *during repose*, showed no difference in the heat of the two sides within the mouth or ear. * * Under a tonic course of treatment he gained ground rapidly. The eyes became less sensitive, the pupils more nearly alike, the line of the lid straighter. * * He was at last able to return to duty October, 1863.

Eulenberg and Guttman*, refer to two cases of injury of the sympathetic of similar kind.

Whilst in the preceding cases, injuries of the sympathetic nerve were attended with contraction of the pupil and congestion of the conjunctiva, as in the experiments, upon certain animals, detailed by Reid and others, it is worthy of note that the changes did not result in the destruction of the eyes by inflammation as occurred in some of the experiments of Petit, Dupuy and Brachet, but indicated rather marked circulatory disorder in the muscular structures of the blood-vessels supplied by the sympathetic. Brachet relates several experiments to show that injury of the sympathetic or destruction of its superior cervical ganglion is attended by great vascular congestion of the anterior and middle lobes of the brain, producing drowsiness and stupor ; the experiments of Dr. John Reid, however, did not confirm those of M. Brachet. It is worthy of note however, that pain in the head and stupor and loss of memory were observed in the case of section of the sympathetic reported by Dr. S. Weir Mitchell.

Contraction of the pupil, consequent upon lesion of the sympathetic in the neck, is not noticed in the experiments of Cruikshank,[1] Arnemann,[2] Mayer[3] of Bonn, and Brachet, whilst this effect is described by Petit,[4] Molinelli,[5] Longet[6] Valentin[7] and others. In the experiments of Camerer,[8] and Pommer,[9] detailed in the treatise of Stilling[10] on spinal irritation,

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[*] Die Pathologie des Sympatheticus auf Physiologischer Grundlage. Berlin, 1873. Pages 8–9.

[1] Phil. Trans., 1795. Part I.

[2] Versuche über die Regeneration der Nerven, S. 69–102. Gottingen, 1787.

[3] Journal der Chirurgie, Von Graefe und Walther, Zehnter Band, S. 418, 1827 ; and Functions du Systeme Nerveaux Ganglionaire. Chapter ix, 1830.

[4] Mémoire dans lequel il est Démontré que les Nerfs Intercostaux Fournissent des Rameaux, qui se Portent des esprits les Yeux ; dans l' Historie de 'l Académie Royale des Sciences, Anná, 1727.

[5] Comment Bononiensi, tom. iii, 1755, p. 280.

[6] Anatomie et Physiologie du Systême Nerveux, etc., tom. ii. p. 353, Paris, 1842.

[7] De Functionibus Nervorum Cerebralium et Nervi Sympathetici. pp. 109, 114, Bernæ, 1839.

[8] Versuche über die Natur du Krankhaften Magenerweichung, 1828.

[9] Beitrage zur Natur, und Heilkunde, 1831.

[10] Physiologische, Pathologische und Medicinisch-Practische Untersuchungen über die Spinal Irritation, S. 139, 140, Leipzig, 1840.

no change was observed upon the eyeball in the rabbit after section of the sympathetic and vagus in the neck: similar results were obtained by Arnold, in his experiments upon hens and pigeons, and he concludes that the effects upon the eye, which follow lesion of the vagus in the dog, depend upon the injury of the sympathetic and not of the vagus, as had been conclusively established by the experiments of Reid on the cat. Longet also determined that in the rabbit, the contraction of the pupil was dependent upon section of the sympathetic and not upon that of the vagus. From his careful and extensive experiments, Valentin concluded. that the iris derives its motor filaments from two sources—from cerebral and from spinal nerves; its cerebral motor filaments come from the inferior branch of the motor oculi nerve: its spinal motor filaments from the spinal cervical nerves; these latter in the rabbit come from the superior cervical nerves, and enter on their passage upwards, the superior cervical ganglion of the sympathetic and the ganglion of the trunk of the vagus (ganglion inferius.) In the dog, on the other hand, they come also from the lower spinal cervical nerves, and join the united trunk of the vagus and sympathetic in the lower part of the neck. The cerebral filaments move the circular muscular fibres of the iris or the contractor muscle of the pupil: the spinal filaments move the radiating muscular fibres of the iris, or the dilator muscle of the pupil. When therefore the spinal motor filaments are cut in the neck, the dilator muscle is paralyzed, while the contractor muscle, no longer antagonized by the extensor muscle, is permanently contracted, and the pupil is consequently diminished in size. Valentin infers, that the arrangement of the spinal motor filaments of the iris in the human species, resembles that of the rabbit; and he also expressed the belief that this view of the motor nerves of the iris. being derived from two different sources, and supplying antagonist muscles, will not only explain the effects of lesion of the sympathetic and vagus in the neck upon the iris, but enable us to understand the variety in the condition of the pupil as to contraction and dilatation in certain diseases, which have hitherto puzzled medical men, and also clear up some anatomical anomalies in the origin of the ciliary nerves which have been recorded. Mr. Paget,* mentions several cases of injuries of the brachial plexus at the base of the neck, in which the pupil of the eye on the side injured, was altered in size. Dr. Hughlings-Jackson suggested to Mr. Paget that the change in the pupil, in injuries of the brachial plexus, might be due to the relations of this plexus to the cillo-spinal portion of the spinal cord. This region, as we have just seen, was first indicated by Valentin, and subsequently more fully investigated by Budge and Waller and extends from the first cervical to the sixth dorsal vertebra, or even so low as the tenth, according to Brown-Sequard. Within these limits irritations of the cord act on the pupil, precisely as do similar agencies addressed to the sympathetic nerve itself.

M. Claude Bernard, in 1852, laid before the French Academy his remarkable experiments on the sympathetic system. (Comptes Rendus, vol. xxxiv., p. 471; Premiere Semestre. Février, 1852.) Having divided the sympathetic in the neck of a rabbit, this distinguished French Physiologist observed an elevation of temperature in the tissues on that side of the head, ranging between 5° and 7° Fahrenheit. When contrasted with the uninjured side, this increase of heat was plainly perceptible by the hand, and admitted of accurate measurement by the introduction of the bulb of the thermometer within the nares, or into the external auditory meatus. While however, this development of heat was most evident on the side of the neck where the sympathetic had been divided, and least so in the opposite corresponding region, where it had been left uninjured, the whole body shared, to a certain extent, in its production, and exhibited evidences of a temperature exceeding the natural standard; indeed. not much difference was apparent between the warmth of the abdomen and rectum and that of the side of the head which had undergone mutilation. This elevation was not a transitory phenomenon, but persisted with remarkable steadiness till the animals were killed; and even after death, Bernard found the side of the neck, on which the experiment had been practiced, the last part of the body to lose its vital heat—the last in fact to die. No signs of inflammation or of any other disorder exhibited themselves, to which this augmentation of temperature might be reasonably referred; for although, in the first instance, it was accompanied by increased vigor of the circulation and vascular turgescence, yet these conditions subsided in a few days, while the temperature itself, showed no symptoms of diminution. When the sympathetic nerve in the neck was divided, or the superior cervical ganglion extirpated, the temperature of the side operated on increased rapidly, and in some cases in a quarter of an hour had risen 11° F.; the arteries and small vessels dilated, and became much more full of blood than those of the opposite side; the pupil contracted, as well as the palpebral opening, while the globe of the eye appeared depressed in the orbit; the hyperaemia, which is the immediate result of the operation, subsides considerably in a day or two; but the elevation of temperature is much more persistent, lasting in rabbits 16 to 18 days, in dogs 6 weeks to 2 months. Bernard has shown, that not only the superficial parts, but the deep-seated. and even the blood returning by the jugular vein, is hotter than the corresponding parts of the healthy side, or than they themselves were previously. Both Bernard and Brown-Séquard have observed that the temperature on the sound side falls below its previous figure, the difference in one experiment amounting to 5½° F.

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*Medical Times and Gazette. March, 1864.

The important circumstance has also been noted, that the phenomena just described are more prominently marked in healthy and vigorous animals than in those that are weakly, and in those that are digesting food, than in those that are fasting. When an animal whose cervical sympathetic has been divided on one side is exposed to a temperature above that of its own body, the side where the nerve is entire gains heat, while the other remains almost unchanged; and before long no difference can be detected between them; on the other hand, when the animal is placed in a medium considerably colder than its own body, the difference between the normal and the operated side becomes more prominently marked; the former losing heat much faster than the latter, and the thermometer showing that it may become as much as 21° F. colder than its fellow.

Brown-Séquard,* found that the phenomena which follow section of the cervical part of the sympathetic, are mere consequences of the paralysis and therefore of the dilatation of the blood-vessels; the blood finding a larger way than usual, arrives there in greater quantity, therefore, nutrition is more active, and the sensibility is increased, because the vital properties of the nerves are augmented when their nutrition is augmented. As to the elevation of temperature, Brown-Séquard, has seen as M. Claude Bernard has, that the ear exhibits sometimes, one or two degrees Fahr. more than the rectum; but the temperature of the rectum is a little lower than that of the blood; and as the ear is full of blood, it is very easy to understand why it has the temperature of the blood. Brown-Séquard based his opinion in part upon the following important experiments: If galvanism be applied to the superior portion of the sympathetic after it has been cut in the neck, the vessels of the face and of the ear after a certain time begin to contract; their contraction increases slowly, but at last it is evident that they resume their normal condition, if they are not even smaller. Then the temperature and sensibility diminish in the face and the ear, and they become in the palsied side the same as in the sound side. Brown-Séquard concludes, that the only distinct effect of the section of the cervical parts of the sympathetic, is the paralysis and consequent dilatation of the blood-vessels; that the cervical sympathetic sends motor nerve fibres to many of the blood-vessels of the heart; and that the blood-vessels are contractile, and that the nerves are able to put them in action.

It was long known that certain injuries of the nervous system might be followed by a partial or even general elevation of heat. Chossat found a considerable diminution in the temperature of dogs, after the section of the inferior portion of the spinal cord; but in two cases, where the spinal cord was divided at about the level of the last dorsal vertebra, he found an increase in the animal heat. In one of these experiments the increase was from 105°.98 F. to 106°. 7 F.; in the other from 105°.98 F. to 109°.6 F. (Mèm. sur l'influence du Syst. Nerv. Sur la Chal. Anim: Thèse de Paris, No 126, 1820, p. 35, Exps. xxiii and xxiv.) An increase in the temperature of parts paralyzed in consequence of the division of their nerves, was also noticed by Dr. Macartney, (Treatise on Inflammation, 1838, p. 13.) H. Nasse, who made many experiments on this subject, sometimes observed an elevation in the temperature of the paralyzed parts after the division of the sciatic nerve, or after the partial destruction of the spinal cord, (Vutersurchunger Zur Physiol, und Pathol., 1839, v. ii, p. 190.)

Brown-Séquard has seen several cases, in which an accidental injury of the spinal cord was attended with marked elevation of temperature. The most remarkable of them, was that of a man who was admitted into St. George's Hospital, in whom there was a forcible separation of the fifth and sixth cervical vertebræ, attended with an effusion of blood within the theca vertebralis, and laceration of the lower part of the cervical portion of the spinal cord. Respiration was performed by the diaphragm only, and, of course in a very imperfect manner. The patient died at the end of twenty-two hours; and for some time previous to his death, he breathed at very long intervals, the pulse being weak and the countenance livid. At last there were not more than five or six inspirations in a minute. Nevertheless, when the ball of a thermometer was placed between the scrotum and the thigh, the mercury rose to 111° of Fahrenheit scale. Immediately after death, the temperature was examined in the same manner, and found to be the same. In more than twenty experiments, Brown-Séquard, only once found an increase of temperature of the leg of a guinea-pig, after the section of the sciatic nerve. This increase lasted about two or three days after the operation, and amounted to 2° F. After a complete transversal section of the spinal cord in the lumbar region, in birds and mammals, Brown-Séquard, found repeatedly, an increase of one, two or three degrees Fahr, in the temperature of the paralyzed part; and he ascertained that it is not in consequence of an increase of the general temperature of the animal, that such an increase exists—it is to be found only in the paralyzed part. Brown Séquard never found any increase of temperature after a complete transversal section of the spinal cord, either in the cervical or the dorsal region. After a section of a lateral half of the spinal cord, at the level of one of the three or four last dorsal vertebræ, he almost constantly found an increase in the temperature of the posterior limb on the side of the section, the elevation varying from one to four degrees Fahr. but on the contrary, there was a diminution of from one to five degrees Fahr., in the temperature of the other leg. In some cases, in consequence of the increase of temperature on one side and its diminution on the other side, the difference in the temperature of the two limbs, amounted to from six to seven degrees, Fahr.; and together with the increase of temperature in one limb, there is an augmentation of sensibility, and with the diminution of temperature in the other limb, there is also a diminution of sensibility.

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* Medical Examiner, August, 1852. See also Experimental Researches, applied to Physiology and Pathology, by E. Brown-Séquard, New York, 1853, p. 9. p. 73.

From the preceding facts, Brown-Séquard drew the following conclusions:

1st. An injury of the nervous system may produce in the parts, which then become paralyzed, either an increase or diminution of temperature.

2d. The sympathetic nerve and the cerebro-spinal nervous system appear not to be different one from the other, in this respect.

3d. The degree of temperature of paralyzed parts, depends on the quantity of blood they receive; and this quantity varies according to the size of the arteries and capillaries of these parts.

4th. It is a fact hitherto unexplained, that the arteries and capillaries may be either dilated, normal or contracted in paralyzed parts. (Experimental Researches applied to Physiology and Pathology, pp. 73-77.)

More latterly, Bernard has discovered that section of the lumbro-sacral plexus, or of the sciatic nerve was followed by an elevation of temperature in the posterior limbs thus treated, and also that section of the brachial plexus about the first rib, was followed by a rise of temperature in the corresponding anterior extremity. By recent investigations, Bernard has found that there are two sets of nerves in the cervical sympathetic, one oculo-pupillary, arising in the dog from the anterior roots of the two first dorsal; and the other vascular and calorifice, arising from the sympathetic ganglia. He also states that division of the anterior and posterior roots of the nerves proceeding to the posterior extremity, in dogs causes paralysis of motion and sensation, but no change of temperature or vascularity; division of the sciatic nerve, however, raises the temperature 6° to 8° C. (11° to 14° F.). and increases the vascularity. Division of the sympathetic nerves has the same effect, but causes no paralysis. Bernard attributes from these observations, more importance to the proper fibres of the sympathetic, than to those which it receives from the spinal nerves in controlling the local circulation. Bernard has also recorded the important observation, which has been confirmed by C. Hanfield Jones,[*] Weber, S. Wier Mitchell,[†] and others, that œdema or inflammatory action do not supervene after division of the cervical sympathetic, in the abnormally hot parts, so long as the animals continued in good health; but if they fell sick, either spontaneously or from the effects of other operations, the mucus membranes of the eye, and nose on the operated side *only* became very red, swelled, and poured out purulent matter abundantly. If the animal's health improved, these inflammatory phenomena ceased

Upon the results of his experiments upon the sympathetic, Bernard built the theory of a special influence of the sympathetic upon the blood-vessels, and upon calorification, and distinguished the sympathetic system from the motor and sensory nerves, as being *vaso*-motor and calorific nerves.

Bernard[‡] thus formulated his ideas:—

1. Division of nerves of sensation, besides producing anæsthesia, diminishes the temperature of the parts supplied.
2. Division of the motor nerves, besides causing paralysis, gives rise also to *coldness in the paralyzed parts.*
3. Destruction of the sympathetic nerve, which neither produces muscular paralysis nor loss of sensation, is accompanied with a constant and very considerable elevation of temperature.

The most important questions which arose from the results of these experiments were:

First. When the sympathetic is divided, is the increased heat in exact proportion to the excess of blood in the part?

Second. Does the increment of heat remain within the range of temperature which is proper to the internal organs of animals?

Third. Is the regulation of the calibre of the blood-vessels and the rate of circulation in a part dependent upon the proper fibres of the sympathetic, or upon those which although mixed with this system are derived from the spinal cord?

If the two first questions be answered in the affirmative, the phenomena following section of the sympathetic have only a subordinate and comparatively insignificant relation to the production of heat; the section of the nerve merely causing hyperæmia, the consequence of which is, that the normal blood-heat is more perfectly attained and exhibited by the parts thus more richly supplied with blood.

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[*] Studies on Functional Nervous Disorders, London, 1870, p. 20.

[†] Injuries of Nerves and their consequences, Philadelphia, 1872, p. 32.

[‡] Leçons sur la Physiologie et la Pathologie, des Système Nerveux, Vol. ii, p. 490, (1858).

With reference to the third question, if the movements of the vessels depend upon the cerebro-spinal system, then the *sympathetic is not the special vaso-motor nerve.*

Brown-Séquard[*] has shown by subsequent experiments that the result of section of the sympathetic is not so constant as Claude Bernard and himself had at first admitted. Thus, in some rabbits, in which the two ears were warm and vascular before the operation, there was no decided increase in the vascularization and in the temperature of the face, and in very cold weather the extremity of the ear of rabbits, on the side of the section of the sympathetic nerve, remains cold. And as we have seen, it results from the experiments of Brown-Séquard, and from the observations and experiments of Brodie, Chossat, H. Nasse, Macartney and others, that the following opinion of M. Claude Bernard is incorrect. He says: "It is known that injuries of the cerebro-spinal nervous system, constantly produce a total or a partial diminution in the temperature of animals, either when a nerve has been divided, or when the injury is made on the nervous centres."[†] He says also, that an injury of the sympathetic nerve produces a very rapid increase of temperature; so that the sympathetic nerve and the cerebro-spinal nervous system are completely different, one from the other, as to the influence on animal heat when they are injured: the one increasing, the other diminishing animal heat Brown-Séquard has shown, however, that these two effects, viz: increase and diminution of animal temperature, may follow an injury of either the sympathetic or the cerebro-spinal nervous system; and in both cases, the increase may exist, at first, and be followed by a diminution.

Budge[‡] found, that the elevation of temperature is not only produced by division of the sympathetic, but also that injuries of that part of the spinal marrow which lies between the seventh cervical and the third dorsal vertebra, which thus includes the eighth cervical and the first and second dorsal nerves, has the same effect on the temperature of the head. Waller[§] attributes the rise of temperature simply to the paralysis of the circular fibres of the smaller arteries, and the increased supply of blood thus induced by the section of the sympathetic: De Ruyter,[||] noticed no alteration of temperature which could not be explained by the increased access of blood: and Donders[¶] remarks, that in these experiments the temperature of the ears very seldom exceeds that of the rectum, that it is high just in proportion to the amount of blood sent to the ears—that it diminishes when they are congested—and that after ligature of the carotid, the temperature of the ear on the side of the section is not higher than that of the other side, and that if the ears are forcibly rubbed the temperature in both is alike. In numerous experiments Schiff[**] observed that the difference of temperature of the two sides of the head (of the ears), may be very considerable and amount to even 21.°6 to 28.8° Fahr; that the difference of temperature was proportionate to the difference in the quantity of blood in the parts, and that when (as exceptionally occurs), the section of the cervical sympathetic has no effect on the vessels of the ear, there is also no elevation of temperature. Schiff refers the increased fulness of the vessels to paralysis of the blood-vessels, and the increased local temperature to the larger quantity of blood circulating through the part. He also propounds the theory that the sympathetic is not the sole and exclusive vascular nerve of the head, but that the cervical, auricular, the facial, and the trigeminus nerve have a similar function; and that the part of the vaso-motor nerves of the head, which is actually contained in the sympathetic consists entirely of the spinal nerve fibres contained in it; that the vaso-motor nerves pass through the spinal cord, and that a part of the medulla oblongata must be regarded as the centre for the vaso-motor nerves, because those of the head and trunk both meet there. He maintains that in complete spinal paralysis of a part, the temperature of this must be elevated, whilst in incomplete, (i. e. paralysis of motion only), the temperature must be diminished. Schiff claims to have established by experiments, that the vaso-motor nerves of the face, and of the distal portions of the extremities on the one hand; and those of the trunk, the arm (above the elbow), and the upper part of the thigh, on the other hand, form two distinct groups which keep perfectly separate in their course through the spinal cord, so that the latter group of vascular nerves decussates laterally, as does the corresponding group of the other half of the body, which those of the first group fail to do; and further, that when a section is made of the left half of the spinal cord near the medulla oblongata, the vascular nerves of the skin of the face, of the hands and feet, and of the lower part of the fore-arm, and of the leg (below the knee) of

[*] Experimental Researches applied to Physiology and Pathology, pp. 75–76.

[†] Gaz, Med. de Paris, Vol. 7, No. 14, p. 227.

[‡] Comptes Rendus, xxxvi, 377.

[§] Comptes Rendus, xxxvi, 378, 1853.

[||] Dissert, de Actione, Atropæ Belladonnæ, 1853.

[¶] Aantee Kingen Van het Uh, Getr., 1853.

[**] Untersuchungen zur Physiologie, des Nerves Systems, i, 124.

the left side, and on the other side (the right), those of the trunk, the arm (above the elbow), and the upper part of the thigh are paralyzed. In subsequent experiments, Schiff,* excited fever, by the injection of pus into the pleura, or into the vascular system in animals, in whom he had previously divided the left cervical sympathetic, or resected the nerves of one extremity. As soon as the fever set in, the parts unaffected by the section of the nerves, began to rise in temperature, whilst in the parts suffering from the vaso-motor paralysis, which were previously warmer, the temperature either did not rise at all, or only very slowly; and when the febrile temperature was fully established, the organs which before were warmest (the nerves of which were divided), were colder than the corresponding parts of the other uninjured side. He concluded from this, that the paralytic hyperæmia, induced by the nerve section, and that induced by fever, (and congestion), do not depend on the same process; that the latter is of a much more active nature, and that therefore, there must exist in the nerves of the blood-vessels, such elements as, when stimulated, cause an active dilatation; but after section of the nerves, this is no longer possible.

Kussmaul and Tenner,* reduced the increased warmth of the ear, of the side on which the sympathetic was divided, below that of the other ear, and even lower than that of its own temperature, before the section, as soon as in addition to ligating or compressing the carotid on the same side, they also ligated the two subclavians at their origin, and thus prevented the establishment of the collateral circulation: on the other hand, they procured an elevation of temperature, if they only ligated the subclavians, and thus increased the lateral pressure of the blood in the carotid. Compression of the carotid on one side, after previous ligature of the subclavians, produced parallel results, whether the sympathetic was previously divided or not, and the section of the sympathetic produced no greater increase of heat than the increased pressure of the blood. On the other hand, Lussana and Ambrosoli,† after suspending animals by their hind legs, did not find so great an increase of temperature in the ears, as they did after division of the sympathetic: and they express the view that a local pathological process of blood dissolution, induced by the section of the sympathetic, causes the elevation of temperature, and not mere hyperæmia, or increased functional activity. Schiff‡ confirmed the observation of Brown-Séquard, that complete division of one lateral half of the spinal cord in the dorsal region, was followed by a rise in temperature in the hinder extremity of the corresponding side, and a fall of temperature in the opposite limbs.

Tscheschichim,§ after complete section of the spinal cord, in a variety of situations, observed uniformly, a suppression of the active operation of the vessels, and a falling of the general temperature, in addition to the loss of voluntary movements; and he considers the primary cause of this diminished warmth, to consist in the paralytic dilatation of the vessels, their overfulness of blood, (and especially in the veins,) in the hindrance of the free circulation of the blood, and consequently in the increased radiation, or loss of heat. He found that the rapid sinking of the internal temperature after division of the cord, might be diminished, or even prevented, by enveloping the body in bad conductors of heat, (wool, cotton, etc.,) thus hindering the loss of heat from the surface of the body. When however, he divided the medulla-oblongata in a rabbit, near to its junction with the pons, he found that immediately after the operation, the general temperature began to rise, and the pulse and respirations were greatly quickened; after half an hour the temperature was from 102°. 92 to 104°. 18 F.; after an hour, it rose to 108°. 16 F., while the respiration ranged from 78 to 90, and it was impossible to count the pulse. Immediately after the operation, the reflex phenomena became unusually evident, and the least touch excited convulsive movements of the whole body of the animal. After an hour and a half, the temperature reached 107°. 96, F.: after two hours, 108°. 68 F.; more rapid breathing and convulsions set in, under which, in half an hour more the animal died. Tscheschichim, connects these facts with the theory of centres of control, which have their seat in the brain, and regulate the activity of the spinal cord. By the ceaseless activity of these, the intense activity of the spinal cord is diminished; when they are destroyed or isolated, the activity of the spinal cord is morbidly increased, and for some time exhibits an excess of functional activity, (increased reflex action, quickened respiration, acceleration of the cardiac systole and increased animal heat.

Naunyn and Quincke,|| asserted, that after crushing of the upper part of the spinal cord, remarkable elevations of temperature were only met with, when the animal was prevented from losing heat, otherwise there was always a rapid sinking of temperature lasting till death and they conclude that injuries of the cord have a two-fold operation,—an increase of warmth production, and an increase in the amount of heat given off. The contradictory results obtained by different observers, are explained by these contrary forces. They also observed that the rise of temperature was more rapid when the cervical portion of the medulla was divided, than when the section was in the dorsal portion. These observers have also shown, by experiments, that after division of the spinal cord, the temperature can be kept at a low degree by means of quinine, which limits the production of heat.

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* [illegible] Med. Zeitg., 1861, p. [illegible]

* Moleschott's Untersuchungen zur Naturlehre des Menschen und der Thiere, 1856, p. 90–132.

† Gaz. [illegible] Lombardia, 1867, No. [illegible]

‡ Untersuchungen, p. [illegible]

§ Reichert's Archiv, 1866, p. [illegible]

Orig Mitlheil, believes that he has met with cases, which justify him in concluding that there is a centre in the cervical portion of the cord, for limiting the temperature, by irritating which, there is a decrease of temperature; by paralyzing it, there is an increase of heat; and that this centre is to be looked for in the anterior fibres of the cervical portion of the spinal cord. Breuer and Chrobok,* have investigated the question, whether the nerves of a part supply the stimulus which causes the febrile elevation of temperature in an inflamed part, by means of experiments on animals, in whom they have as far as possible divided all the nerves of one part of the body. After the injuries caused by the operation have healed, they have set up local inflammations in the nerveless part; and they think themselves justified in concluding that the fever of the traumatic inflammation is independent of the nervous connections of the inflamed part with thee nerv centres.

Clinical observations furnish only a few cases exactly analogous to the results of experiments on the relations of the nervous system to the temperature of the body; but Wunderlich, after an elaborate review of many of the facts just recorded, considers the following as analogous spontaneous conditions:

1. The local alterations of temperature in neuralgias during the paroxysm of pain.
2. Observations of temperature in paralyzed parts.
3. Observations on variations of temperature in those forms of disease which are considered as vaso-motor neuroses.
4. The effect of mental exertion or excitation in elevating the temperature in cases of disease, the effects of different kinds of delirium, and the moderation of febrile temperature, which is sometimes observed after a quiet sleep.
5. The great elevation of temperature in acute (rapid) inflammation of the brain.
6. The more enormous elevation of temperature in injuries destructive of the spinal cord.
7. The very disproportionate rise of temperature at the end of tetanus and other fatal neuroses.

According to Wunderlich, these facts are favorable to the theory, that a large share in the regulation of heat, belongs at least in complex cases to the nervous system; the influence of certain nerve tracts on the activity of the heart on the one side, and on the circulation on the other, is indeed indisputable; and on this account it may be safely assumed, that alterations in the amount of blood in the peripheral vessels, influence in more ways than one, the warmth of the places concerned, and of the general temperature also. A great part of the pathological phenomena of warmth, may be only the expression of the action of the vaso-motor nerves; and perhaps, even in actual diseases of the nervous system, the fluctuations of temperature, particularly if slight, must be attributed to an alteration in the circulation. But it appears from the lesions of the nervous system which are attended with enormous elevations of temperature, that some hitherto unknown power has sway over animal heat, since the most remarkable alterations of temperature occur with profound disturbances of the nervous system, without corresponding anomalies of circulation, and according to Wunderlich, it is perhaps not too much to affirm, that the integrity of certain parts of the central nervous apparatus is more necessary for the regulation of animal heat, than that of any other part of the body.

Samuel† has advanced the hypothesis of the existence of fibres, distinct from the motor nerves of muscles and vessels, as well as from the sensory, whose office is to preside over nutrition, and which are divisible into a centrifugal and centripetal set; the centrifugal when excited, increase nutrition, when paralyzed, decrease it; on the other hand, paralysis of the centripetal fibres, is the cause of the diminished resisting power of anæsthetic parts to injuries. Samuel, regards fever and inflammation as states of excitement of the trophic nerves; and atrophies as the reverse. Samuel, records various experiments in which irritation of sensory and compound nerves caused intense inflammation of the parts to which they were distributed. Weber has strongly controverted the views of Samuel, and concludes that the influence of nerves upon inflammation is nothing else but the influence exercised by them upon the blood-vessels, and that inflammation cannot be caused either by paralysis or irritation of nerves. Whilst it must be admitted from the various facts recorded by different observers conducting independent investigations, that certain nerves, when stimulated, do excite an influence in the districts to which they are distributed, in the way of increasing the amount of blood circulating through the tissues, by antagonizing the ordinary vaso-motor nerves accompanying the arteries, whose activity induces the opposite condition; at the same time it is doubtful whether the so-called *trophic* nerves are indeed a special set, or whether the same effects may not be produced through ordinary motor and sensory nerves.

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* Wiener Medic, Jahrbücker, XIV, p. 3, 1867.

† Die Trophisce Nerven, Leipzig, Wigand, 1860. Canst. Jahr., vol. 11. p. 53–57, 1861.

Against the doctrine, that the cerebro-spinal and sympathetic nervous system, may directly, by means of special systems of nerves, as the *vaso-motor, trophic and inhibitory* directly increase or diminish animal heat, and directly increase, diminish or alter nutrition and secretion, the following facts and arguments may be opposed.

The well known and almost universally acknowledged facts, that no nerve cells or nerve fibres are found in the entire vegetable kingdom, in which the processes of secretion, excretion, and progressive development of complicated structures and organs, are manifested in perfection: that in the lowest or most simply constituted animals, in which development, digestion, nutrition and secretion take place, as in the more complicated animals, no nerves have been detected: that abnormal products, as the various forms of tumors and cancers, are developed from special germs, without any special nervous intervention, and present uniform products, no matter whether the tissue in which they arise, be well or illy supplied with nerves: as well as the possibility of cutting out and transplanting organs, as the testicle, from one tissue to another, without interfering with the process of growth and secretion; and the independent vitality of the cells everywhere, throughout the most complicated animals, and the apparent impossibility of reproducing the more highly organized tissues in the most highly organized animals, when destroyed: may be regarded as satisfactory proofs, that in animals, the process of development, nutrition and excretion, may go on without the intervention of a nervous system, and that even in the most complicated animals, the process stands in no such relation as that of cause and effect to the nervous force.

The nervous system makes its appearance at a certain stage of development, and is so to speak, a product of preceding vital action. The fact is true of the animal kingdom in its successive stages of development from the most simple organism, to the most complicated, and also of the development of the solids and fluids of each highly organized animal, that there is a simultaneous development of the various organs and apparatus, without the dependence of the one upon the other. Thus in the case of the human fœtus, the most complicated forms of apparatus, as the respiratory organs and accompanying respiratory muscles, are developed and perfected, whilst the system destined to preside over these functions after the birth of the animal, is without any known or demonstrable influence upon the development and perfection and action of the respiratory organs and muscles. The entire brain and spinal cord may even be absent in the fœtus, without any arrest of development of the muscles and thoracic and abdominal organs. In the fœtus, the development and perfection of the entire muscular system appears to be wholly beyond the sphere of the cerebro-spinal system. The entire organic life of animals, or everything which goes on in them, without the intervention of sensation or any other mental act, may go on without the intervention of a nervous system. Chemical change in the organs and apparatus, and chemical change in the nervous system, is the source not only of heat, but of muscular and nervous force, and of all the forces generated in the animal economy. All the acts called vital, and nervous, and muscular, by many physiologists, such as the contraction of the muscles and the transmission of impressions to and from the nervous sensitive centres, along the nerves, are due to the chemical changes of those elements which have been separated from oxygen and elevated into a state of force, capable of chemical change, by the forces of the sun, acting through special organs in the vegetable kingdom. There is a change of force in direction and mode of action, but there is no creation of force. Physical and chemical actions take place in a similar manner in all animals, simple or complex; they differ only in intensity. The higher the animal, the more complicated its parts, the more rapid the chemical changes, and consequent generation of the forces, and the greater is the necessity for some special apparatus, which will bring all the complex organs and apparatus, and actions into harmonious relations. Unless the actions of different organs can be telegraphed (so to speak) to each other, confusion in a complex organism will necessarily result. Thus if the amount of blood circulating through any organ be too great or too little, there must be some medium of communication, and some means of regulating the chemical and physical actions through that special apparatus by which the amount of the blood which furnishes the elements of chemical change may be increased or diminished. The nervous system forms the medium of communication between the intellectual faculties and the exterior world; it connects together and influences the various organs and apparatus, it regulates secretion and excretion and the consequent development of the animal tissues, by regulating the circulation and respiration, and it excites and controls the [illegible] apparatus, not by the possession or emission of a peculiar force generated [illegible] by a modification of physical force generated by the mutual reactions of [illegible] and nervous system. To the nervous system is delegated the property of regulating the action of the circulatory and respiratory apparatus, and thus it controls the amount of oxygen and blood supplied to the organs. The blood supplying the nutritive elements of the tissues and organs, and the materials for the secretions and excretions, and development of the tissues, and oxygen being the active agent in all the chemical actions of living beings, it is evident that whatever disturbs the constitution of the nervous system, necessarily disturbs the functions of the apparatus and organs, and produces corresponding alterations in the secretions and excretions. As the integrity of the nervous system, depends upon the integrity of the blood, in like manner, whatever alters the constitution of that fluid, will produce aberrated action in the nervous system, and in turn, this disturbance may extend indefinitely.

The view which has been held by some physiologists, that the production of animal heat, is *essentially* dependent on *nervous agency*, independent of chemical change, is evidently erroneous, for the following reasons: Heat is generated in the vegetable kingdom during the chemical changes of the nutrition and growth of the cells, without the intervention of nerves; so also in certain diseases, a large amount of heat is generated after death, and the cessation of all nervous agency. The elevated temperature of inflammations and fevers, is attended with a corresponding increase of chemical change in the blood and organs, as is evidenced by the greatly increased amounts of urea, phosphoric acid, sulphuric acid, and extractive and coloring matters in the urine, and carbonic acid in the expired air. Certain agents, as pus and putrid blood, are capable of inducing decomposition and rapid chemical change of the blood when introduced into the circulation. We cannot in the living body, any more than in the exterior organic world, derive physical force and motion from nothing; it must arise from pre-existing motion or force. The chemical changes of the human body, have been shown by careful experiments, to be sufficient in amount and character to develop and maintain animal temperature. When the true calorific equivalents of carbon and hydrogen, are used in the calculation, and the relatively minute quantities of phosphorus and sulphur, are also included, the heat produced by the various chemical changes in the animal body, is adequate to maintain a definite degree, corresponding to the normal temperature, and to compensate for the heat dissipated by radiation, and by the evaporation of the fluid transpired through the skin and lungs. The nervous system may influence the amount of heat, by influencing the respiration and circulation, and possibly also by the conversion or transmutation of its peculiar physical, nervous or electrical force into heat. Depressions and elevations of the animal temperature, may also be due to chemical changes of an abnormal character in the blood and in the nervous and muscular structures, excited by morbific agents, which act chemically upon the organic constituents; whilst at the same time, they may produce such derangement in the actions of the muscular and nervous systems, as to lead to a state of actual prostration and depression.

The view held by certain physiologists, based upon the results of the old experiments of Petit, Cruikshank, Dupuy and Brachet, upon the sympathetic, that the nervous system presides absolutely and wholly over secretion, and is capable of producing all the phenomena of inflammation, and even the absolute derangement and destruction of complex apparatus, has been greatly modified by the results of more recent and careful experiments; and the influence of the nervous system and especially of the sympathetic, has been gradually narrowed down within definite bounds. As we have shown by a careful examination of the labors of various physiologists, the marked tendency of the more careful experiments, is to reduce the phenomena to the action of well-known physical and chemical laws.

It has been well established that in the lower animals, the action of the heart, as well as of the circulation and digestion, may continue for weeks after the destruction of the central mass of the nervous system. Thus Bidder carefully removed the arches of the cervical vertebræ of frogs, so that little blood was lost during the operation, and then completely destroyed the spinal cord. Frogs treated in this way often lived six weeks, and sometimes ten, the circulation in the web of the foot remaining at the same time active and not differing from that of uninjured frogs. The heart beat powerfully and quickly; in a freshly killed frog, in winter, the heart pulsated thirty-five times in the minute; while in a frog, the spinal cord of which had been destroyed twenty-six days previously, the pulsations were forty per minute. When the brain and spinal cord were destroyed, the medulla oblongata being left, frogs were retained in life until the sixth day; and when the entire central organs of the nervous system were removed, they lived until the second day; the rapid ensuing death in the latter case being due according to Volkmann, to the effects produced upon the respiration. Within a few weeks after the destruction of the spinal cord, the muscles of animal life were found to have lost their irritability in a marked degree, and still later no contraction could be produced in them by application of chemical or mechanical stimuli; the heart, however, in such cases still continued to pulsate eleven times in a minute, and retained its property of responding to external stimuli. The intestinal canal, in like manner, retained its irritability; application of stimuli giving rise to contractions which were sometimes of a local nature, at other times extended for a considerable distance on either side of the part stimulated. Digestion in like manner, suffers but little from destruction of the central parts of the nervous system: healthy frogs, and others, which had been operated upon, were, after being starved for a considerable time, fed with worms, and kept in separate glasses. In the one, as well as in the other, the worms, were found after twenty-four hours, to be fully digested, and the stomach and duodenum, were filled with colored mucus; such was observed to be the case,

[illegible] destroyed twenty-six days previously. The
[illegible] in which the brain or spinal cord has
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[illegible] to an enormous size, unless emptied in the
[illegible] and Stilling, that after destruction
[illegible] derangements in the nutritive processes ensued; there
[illegible] swellings especially of the limbs. On these also sores
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[illegible] Bidder found that when the bottom
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[illegible] artificial means, as well as upon the
[illegible] of Anatomy and Physiology. Vol.
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[illegible] changes, after section of the sciatic nerve
[illegible] dependence of the nutritive operations upon
[illegible] distinguished physiologist, Dr. E. Brown-
[illegible] experiments. He divided the sciatic
[illegible] some of them at liberty in a room
[illegible] the bottom of which was thickly cov-
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[illegible] the extremities of the
[illegible] engorged and covered with fleshy granu-
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[illegible] animals confined in the boxes.
[illegible] been kept living for four, five,
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[illegible] micrographer, (Dr. Lebert),
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[illegible] experiment of Claude Bernard, are
[illegible] of the blood-vessels: the
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the degree of temperature and of sensibility of a part is in close relation with the quantity of blood circulating in that part. We have already dwelt upon the great importance of the fact, discovered by this observer, that if galvanism be applied to the superior portion of the sympathetic after it has been cut in the neck, the vessels of the face and of the ear after a certain time begin to contract; their contraction increases slowly, but at last it is evident that they resume their normal condition, if they are not even smaller. Then the temperature and the sensibility diminish in the face and the ear, and they become in the palsied side the same as in the sound side. When the galvanic current ceases to act, the vessels begin to dilate again, and all the phenomena described by Dr. Bernard re-appear. Dr. Brown-Séquard concludes from these experiments, that the only direct effect of the section of the cervical part of the sympathetic, is the paralysis, and consequent dilatation of the blood-vessels. Another evident conclusion is that the cervical sympathetic sends motor nerve fibres to many of the blood-vessels of the head. Certain experiments prove that the blood-vessels are contractile, and that the nerves are able to put them in action. It has been established by Budge and Waller, that the cervical sympathetic is one of the motor nerves of the iris, and that the spinal cord is the origin of the nerve fibres going from the sympathetic to the iris. On the other hand, Bernard doubts that the effect of dividing the sympathetic is to paralyze the arteries, and so cause their dilatation; and regards it as an anomaly that arterial paralysis should promote greater activity of the circulation. That paralysis of the arteries should promote a greater activity of the circulation, is, however, evident, when it is established that arterial contraction has necessarily the opposite effect, and diminishes the afflux of blood to the part. Thus, when the arteries in the frog's web are made to contract by the application of cold, the capillaries appear empty and devoid of red particles; on the contrary, when the web is warmed, the arteries immediately pour in blood abundantly. The recent observations of Bernard (La. Clin. Europ., 1859, No. 29, p. 282; Syd. Soc. Gen. Book, 1861, p. 29), demonstrate very clearly that paralysis of the sympathetic nerves increases and accelerates the arterial current. When a manometer was inserted into the right coronary artery of the lip of a horse, and another into the left, both instruments showed a pressure of 160 to 180 millim; the pressure of blood increased 40 millim on the left side after division of the corresponding cervical sympathetic; in the coronary veins of the lip, the instrument showed a pressure of 30 or 40 millim, which increased to 50 or 60 after section of the sympathetic, while the pressure again fell 20 millim when the nerve was galvanized. Pulsation of the veins and a brighter color of the venous blood, were also noticed as results of division of the same nerve. Dr. C. Handfield Jones, in his valuable and profound "*Studies on Functional Nervous Disorders*," has well observed, that "the old and oft-used phrase, 'great arterial action,' descriptive of a larger and bounding pulse, when translated into correct physiological language, means, of course, great *cardiac* action, with a *want* of arterial."

Ackermann and Bergson (Syd. Soc. Year-Book, 1860, p. 131, Virchow's Arch., Vol. xv. p. 401); made an opening in the skull of rabbits, removed a portion of bone, and of the corresponding dura mater, and closed the aperture with a glass plate and collodion; they were thus enabled to observe the varying state of the vessels of the brain: section of the right cervical nerve was found to cause injection of the diploë, and of the cerebrum of that side; and three hours afterwards when the left nerve was divided, the injection of the corresponding cerebral vein became equal to that of the right side. Jachkowitz has shown that section of the sympathetic plexus of the splenic artery causes congestion of blood, softening and disintegration of the capsule: if part only of the plexus is divided, the corresponding part only of the spleen is affected. In the experiments of Samuel upon rabbits, dogs and cats, the hyperæmia of the intestinal mucous membrane produced by extirpation of the cœliac plexus was so great that it exceeded all pathological hyperæmias hitherto known. The secretion of the mucous membrane is increased by the operation, but not to the same degree as in a violent diarrhœa. After removal of the lower part of the spinal cord and the roots of the nerves in a frog, Wharton Jones found that the arteries of the webs retain all their contractility, or are even more than usually disposed to be constricted: if now the ischiatic nerve be divided on one side, the result is, that the skin of the extremity subjected to the experiment becomes, even to the naked eye, redder from vascular congestion than that of the opposite extremity; and on examination of the web under the microscope, the arteries are found to be considerably dilated—in the web of the opposite extremity, on the contrary, the arteries are seen still much contracted, some even to closure. Such facts illustrate in a clear manner the control of the sympathetic nerves accompanying the arteries over the circulation, and through the circulation upon the nutritive actions.

The vaso-motor system of nerves is without doubt concerned in the phenomena of Fever, and especially in the chill and cold stage of malarial Fever: it is nevertheless probable that specific fevers are caused by the action of specific poisons, which derange the constitution of the blood primarily, and secondarily induce disturbed nervous action. Whilst there is an undoubted contraction of the smaller arteries in the cold stage of malarial fever by which the blood is forced as it were into the more vascular and less resisting organs, at the same time there is a marked elevation of temperature in the central organs. The great reduction of the temperature of the surface and extremities is evidently due to the withdrawal of the blood by the contraction of the minute arteries; but it is not clear, that the elevation of the blood in the central organs is due to the nervous influence, for it may be the result of the increased frequency of the respiration and heart beats and the action of a specific poison inducing destruction of the fibrin and blood corpuscles.

In those cases of Traumatic Tetanus in which a sudden and great rise of temperature precedes death, other causes as acute inflammation of the spinal marrow, the generation of pyogenic compounds and the retention of carbonic acid from impeded respiration, may be active in producing this remarkable phenomenon. The same observation applies to the elevation of temperature following injuries of certain portions of the nervous system and especially of the spinal cord. Until thorough investigations are instituted into the changes of the blood, the force and frequency of the pulse and circulation, the amount of oxygen consumed and the carbonic acid exhaled and the amounts and characters of the renal and cutaneous excretions in the various conditions characterized by sudden and great elevation of temperature, the doctrine of special nervous centres of control of heat and nutrition, must rest only upon a hypothetical basis. The tendency of recent investigations is to re-establish the so-called *Humoral* Pathology and locate the origin of inflammation and even of Cancer, Tubercle and Scrofula, in certain changes of the blood. The migration of the colorless blood corpuscles through the walls of the capillaries have been shown by Cohnheim and others to be of prime importance in the phenomena of inflammatory diseases.

The experiments of Ludwig and Bernard, have shown conclusively that the sympathetic or vaso-motor system of nerves are not the only organs which act upon the circulation, but the stimulation of the fifth pair and of the facial produces a greatly increased flow of saliva, while at the same time the circulation of the gland is accelerated.

The essential idea of the *inhibitory theory*, is that a peculiar kind of impression made on a nerve may lower or paralyze its action and prove directly depressing. Thus Weber and Bernard long ago demonstrated the possibility of arresting or diminishing the action of the heart by galvanizing the medulla oblongata or the pneumogastric nerve. (Leçons sur le Système Nerveux, tome [illegible], p. [illegible].) The subsequent experiments of Pflüger and Lister, have shown that galvanization of the spinal cord may induce complete relaxation and quiescence of the intestines which had been previously in active movement, while the muscles of the limbs were thrown into spasmodic movement. Such experiments prove that slight electric irritation of the medulla oblongata augments, while more powerful irritation diminishes or even arrests the heart's action. Powerful mechanical irritation of the medulla oblongata diminishes the frequency of the heart's action. Slight irritation of the spinal cord increases, while powerful irritation diminishes the frequency of the heart's action. We are scarcely justified from such experiments to conclude that the dilation of the vessels is an active phenomenon and dependent upon a special system of nerves, the so-called *vaso dilators* and vaso contractors: neither can the view of Eulenburg and Landois be adopted as proved, that there are four systems of so-called inhibitory nerves, viz: the cardiac, the respiratory, the intestinal, and those which restrain the reflex movements. The conclusion of Lister, appears to be more in accordance with the facts, that one and the same afferent nerve may, according as it is operating mildly or energetically, either exalt or depress the functions of the nervous centre on which it acts. The phenomena may be explained by referring the contraction of the vessels and the consequent diminution of blood supply and of nutrition and calorific and muscular actions, when the nerve is irritated, to an influence conveyed along the nerves to the muscular tissue; and by referring the reverse phenomena characterized by dilatation of the vessels, increased blood supply, increased chemical and nutritive and secretory changes and elevation of temperature, to simple paralysis or loss of vascular tonus. It must be clearly borne in mind that, relaxation of the muscular fibres of the arteries of such an organ as the heart accompanied with increased supplies of oxygen and blood, would necessarily be attended by increased nutrition and increased action in the muscular structures proper to the heart itself. A complete investigation of the so-called *Inhibitory* actions, should embrace a minute quantitative determination of the amounts and changes of the blood and of the structures of the various organs subjected to experiment, as well as of the so-called regulating and inhibitory ganglia and nerves.

Brown-Séquard has shown, that the view held by many physiologists, that the secretion of the gastric juice is stopped after the section of the two pneumogastric nerves is erroneous. It is difficult to solve the question by experiments on warm-blooded animals, because they die too quickly after the section of the vagi; but not so with frogs, they are able to live several weeks, either after the extirpation of the medulla oblongata, or after the extirpation of the ganglia of the par vagum. In both these cases, the digestion continues to be performed. This observer repeated the experiments of J. Reid, with similar results, viz: when all the nerves, both cerebro-spinal and sympathetic of the posterior limb in frogs are divided, and if the galvanic current be applied every day to the palsied limbs on one side, these galvanized limbs retain their natural dimensions, whilst the palsied limbs not galvanized become atrophied. Moreover, if the application of galvanism in made on the palsied limbs of very young animals, and continued every day until they arrived at adult age, the limbs are then found to have grown as much in every respect as the sound limb. In these experiments, galvanism appears to act in two ways: in the one by exercising the muscles and increasing in consequence their nutrition; in the other by producing directly some of the chemical changes which constitute nutrition. The atrophy which happens in paralyzed muscles, takes place mostly, because they remain without exercise, and partly, because when nervous action is deficient the respiration of the muscles is not carried on as well as when the nervous system acts upon them. Galvanism applied to a palsied limb acts partly in producing the transformation of arterial blood into venous blood, i. e. what Gustav Liebig calls the respiration of the muscles. Brown-Séquard has seen frequently, the venous blood, in palsied limbs, becoming as black as normal venous blood, after the application of galvanism, and he attributes this change of circulation. not to a direct chemical influence, exerted by galvanism on the blood, for if galvanism be applied to blood in a vase, no change of color is produced, but to an interchange between blood and the living tissues. From the preceding facts, Brown-Séquard concludes, that *Nervous Action is not necessary for Nutrition.* (Experimental Researches, applied to Physiology and Pathology, pp. 6–12).

The researches made before those of Brown-Séquard, as to the influence of the spinal cord on the uniary secretion, could not give a decided result, because no physiologist, had been able to keep any warm-blooded animal living a sufficient time, after the destruction of a large part of the spinal cord. This observer kept living, nearly three months, a young cat, on which the spinal cord had been *completely destroyed* from the eleventh to the twelfth costal vertebra to its termination. This cat lived all that time in apparently good health, and its urine was always perfectly normal. It was acid, as is the case constantly in cats fed on meat, milk and bread. The bladder was paralyzed, but the sphincter vesicae generally contracted, so that it was necessary every day to compress the abdomen, and the bladder to empty this pouch. When this operation was neglected for two days, the bladder contracted in consequence of the excitation produced on its muscularfibres by their distension. This fact clearly proves, that the urinary secretion is not under the dependence of the spinal cord. Brown-Séquard has also shown that the opinion of Krimer, that the urinary secretion depends upon the medulla oblongata, is incorrect. Thus, after destruction of the medulla oblongata, in frogs, the secretion of urine continues as long as the animals had lived, i. e., three or four months; and when the medulla oblongata is extirpated in hybernating animals, after having emptied the bladder, with proper attention to the respiration, these animals have lived a little more than a day, and after death, the bladder was found full of urine, apparently normal. The medulla oblongata, therefore is not a centre on which the urinary secretion depends.

Brown-Séquard has in like manner shown that the opinions of Segalas, W. Philip, Krimer, Chossat, Longet and others, about the influence of the spinal cord on the functions of organic life, are quite erroneous. Birds are able to live for months, after the destruction of the spinal cord, from the fifth vertebra to its termination. This fact proves not only that the functions of organic life may continue to exist in such a case, but that they appear to be executed then as in healthy birds; for if the operation has been made on a young bird, it will afterwards grow very well. This physiologist succeeded in keeping alive, from the 8th of April, until the 4th of July, a young cat, in which the spinal cord had been destroyed to a similar extent; the palsied parts grew in length proportionally as much as the sound parts, and acquired more than double the length they had at the time of the experiment, the nutritive reparation was so powerful that the pieces of the vertebral column, which had been cut off. were reproduced, the functions of organic life existed without any apparent disturbance, the temperature remained at the ordinary degree in the rectum, the secretion of the hair and nails took place as in healthy cats. In birds, the temperature remained normal after the destruction of a great part of the spinal cord, and the secretion of quills and nails continued to take place. As to the influence of the medulla oblongata on the functions of organic life, Brown-Séquard's experiments on cold-blooded animals, have proved, that the functions, (except, of course, pulmonary respiration), may continue to exist, without any appearance of disturbance. (Experimental Researches, pp. 13–15). After the complete transverse section of the spinal cord in mammals or birds, it has also been shown, that the ulcerations which take place around the genital organs do not result directly from the absence of nervous action, but from continued pressure, and the continued presence of altered urine and fæces.

M. Cl. Bernard, by his wisely devised and carefully executed experiments, has shown, that in certain glands, the chemical conditions which cause the venous blood to appear at one time red, and at another black, are determined by the influence of two nerves, which have distinct origins and possess powers apparently antagonistic to each other. Each of these nerves, in order to produce a chemical action on the blood, modifies the mechanical phenomena of the capillary circulation, so that there is established a correlation, both necessary and easy to be understood, between the chemical changes which the blood in the organic tissues undergoes, and the mechanical conditions of the capillary circulation, which are under the immediate influence of the nerves. The experiments which led to these results, were made upon the submaxillary gland of the dog, which is particularly adapted to this kind of research on account of the intermittence in its act of secretion, exhibiting very clearly the variations in the color of the venous blood. The nerve which causes the venous blood to appear red in the veins of the submaxillary gland, is a small branch which arises from the posterior portion of the lingual branch of the fifth pair: but it is only in contact with the fifth pair, coming really from the seventh, and is principally formed by the chorda-tympani: whilst the nerve which renders the venous blood in the submaxillary gland, black, is derived from the great sympathetic, and accompanies the arterial branches of the carotid. When the vein and nerves of the gland are exposed, and an impression upon the nerve of taste is produced by dropping a little vinegar in the mouth, the blood rapidly reddens in the vein, because the impression of taste produced upon the tongue and carried to the nervous centres, has been transmitted by reflex action through the corda-tympani. The proof of the truth of this interpretation of the phenomena, is immediately furnished, for when this nervous filament is cut at the point where it separates from the lingual nerve, the venous blood of the gland remains black, and from that moment, notwithstanding the application of vinegar upon the tongue, and the impression upon the nerve of taste, the red color of the blood does not appear, because the nervous medium by which the modifying influence of the blood was conducted has been interrupted. But if the cut extremity of the nerve next the gland, be irritated by means of galvanism, the blood in the glandular veins becomes red, and resumes its black color when this excitement ceases. If all the filaments of nerves which go from the great sympathetic to the gland be cut, the venous blood loses its black color, and takes a russet color, which becomes permanent, because the influence of the great sympathetic nerve has been interrupted and does not reach the gland. But if the action of this nerve be re-established, by applying galvanism to its glandular extremity, the venous blood becomes very black, and again resumes its red color, as soon as the galvanic influence, ceases to act upon the nerve. Thus the variations in the color of the venous blood in the gland, are due to two nervous influences, well marked and perfectly distinct. In endeavoring to understand the mechanism of the influence over the blood, it is evident that there in no anatomical continuity between the nerves and the globules of the blood, and that it is necessary that there should be other phenomena intermediate between the nervous action and the chemical change, in the globules of the blood; and these intermediate conditions do exist, and consist in the different mechanical changes, which each nerve produces in the capillary circulation of the gland. The mechanical conditions of the capillary circulation, produced in the submaxillary gland, by the tympanico-lingual, and the great sympathetic nerves, are exactly the opposite of each other. When the tympanico-lingual nerve is excited, the venous blood appears of a red color, and at the same time there comes on a considerable activity in the rapidity of the circulation: in proportion as the venous blood becomes redder, it flows more and more rapidly, and the quantity which flows through the vein is much increased. When the influence of the great sympathetic predominates the venous blood is blackened in color, and at the same time its circulation becomes sluggish; the blood flows through the vein with a current slow in proportion to the intensity of its color; and even if the action of the sympathetic nerve, is sufficiently excited, the current of the blood may entirely cease, to re-appear the moment the excitement of the nerve ceases, and again accelerated if the tympanico-lingual nerve is irritated. The red and black color of the venous blood is a fixed relation to the activity of the circulation in the submaxillary gland. But this rapidity in the circulation of the blood cannot be produced directly by the nerves, for they have no direct and intimate action on the blood itself. The contraction and expansion of the blood-vessels of the gland, can also explain the modifications in the properties of the blood. Bernard has proved by experiments, that one of the two nerves of the submaxillary gland dilates the vessels, while the other contracts them. When the action of the tympanico-lingual nerve is intense, the increase in the calibre of the capillary vessels is so marked, that the blood passes from the artery into the vein without losing the impulse of the heart, and makes its exit from the vein of the gland, with an interrupted jet as of a true artery. This venous pulsation disappears, as soon as the action of the tympanico-lingual nerve diminishes or entirely ceases. The sympathetic nerve, on the contrary, contracts and narrows the calibre of the glandular vessels in the most marked manner.

These experiments of Bernard establish the important fact, that the nerves act only as agents of the dilation and contraction of the blood-vessels; and although the nervous influence in secretion does not differ from that of the motor nerves in general over muscular tissue, nevertheless, by a very natural succession of phenomena, it produces a series of physico chemical changes in the blood. When the sympathetic nerve, the constrictor of the vessels is active, the contact between the blood and the glandular elements is prolonged, the chemical phenomena, which results from the organic changes between the blood and the tissues has time to take place, and the blood flows of a black color. When on the contrary, the tympanico-lingual nerve which dilates the vessels is active, the passage of the blood through the gland becomes very rapid, the modifications of the blood which take place in the contact of the blood-globules with glandular tissue are accomplished with a different result, and the blood comes from the vein with a very red color and preserves the appearance of arterial blood.

Thus has this physiologist shown, that even secretion may be referred to chemical and physical laws; and that the special nervous system, which animates each capillary system and each organic tissue, regulates eveywhere the current of blood in its relation to the special physiological acts of the organs; these nervous modifications of the capillary circulation take place, in situ and without the least disturbance, to the neighboring organs, still less to the general circulation; each part is connected with the whole, by the common states of the general circulation, also by means of the nervous system, and each part may thus have its appropriate circulation and physiology.

Whilst the experimental researches of Bernard, on the Great Sympathetic, instituted to determine the relations of this nerve to the organic changes taking place in living tissues, establish that section of the nerves of sensation is attended with abolition of sensation and diminution of temperature, that of the nerves of motion with paralysis and cooling, section of the sympathetic with no loss of motion or sensation, but with an increased afflux of blood, into the dilated vessels, and with an augmentation of temperature, section of the spinal marrow and nervous tracts enclosing the commissures of the nerves of sensation and motion and of the sympathetic, paralysis of movements, and sensation and dilatation of vessels, and augmentation of heat; at the same time a careful comparison of the results of these experiments, have shown that in no case was the section attended with the cessation of nutrition and secretion and the essential phenomena of inflammation. In section of the cervical sympathetic, the dilatation of the arteries and afflux of blood accompanied by elevation of temperature and corresponding congestion and redness, resembling in all respects similar manifestations in inflammation, may exist for days and weeks and even months, without any apparent change in the tissues, or the increase of the parts by inflammatory exudation, or through the effused serum. By its distribution to the arteries, the sympathetic, as a compound nerve of sensation and motion, exerts a power over the passage of the blood through the vessels by influencing the contractility of their muscular fibres. It thereby affects the rapidity of circulation, and also regulates the entire rate of secretion. The entire digestive tract and its dependencies, as the salivary glands, Œsophagus, Stomach, Pancreas, Liver and Intestines, are thus brought under its influence. The influence of the sympathetic in secretion therefore, does not differ essentially from that of the cerebro-spinal system, and it is therefore necessary to modify the old views which prevailed for nearly a century with reference to the so-called nervo-pathological inflammations and nervo-secretory (excito-secretory) actions.

If the statement of Jacubowitsch be accepted, viz: that sympathetic cells exist in certain parts of the spinal cord; and if the observations of M. Luys, indicating the existence of a continuous column of sympathetic cells extending along the inner face of the posterior horn of gray matter in the cord for its whole length up to the brain, be regarded as correct: the vaso motor centres in the cerebro-spinal system, indicated by the experiments of Budge, Waller, Claude Bernard, Brown-Séquard, Schiff, Masius, Salskowsky, Ludwig, Thiry and Kronecker, and others, may be regarded as belonging to the sympathetic system, and similar in all respects to the organic ganglia found outside of the cavity of the cranium and spinal column. The vaso-motor phenomena, would be simplified by such a view; and certain pathological phenomena, as the increase of heat and increase of the capillary and general circulation might find a ready explanation. Thus the introduction of a poison, or of the product of inflammation into the blood, might induce paralysis of the vaso-motor centres of the sympathetic system within and without the cerebro-spinal axis. The central organ of the circulation, that is, its muscular structures being excited to increased action, by the increased supply of blood, and the blood being driven more rapidly through the entire course of the circulation; and the muscular apparatus of respiration, being at the same time excited to increased action; all the essential conditions of fever, viz: the rapid introduction of oxygen and its rapid distribution through the dilated vessels; rapid chemical change and elevated temperature, may thus be established by the action of a morbific agent upon the vaso-motor system of nerves. According to this view, the increase in certain excrementitious products, result from increased chemical changes resulting from the establishment of those conditions of the respiration and circulation favorable to the rapid transformation of the elements of the blood and tissues into crystalloid products: and the relations of the nervous system to these changes is indirect, that is, by its action upon the apparatus devoted to the æration (oxidation oxygenation) and circulation of the blood.

Whilst admitting that the ganglia of the sympathetic constitute centres of nervous excitation, from whence the organic muscles and other contractile tissues receive the motor impulses, and the heart and circulation generally their regular actions, just as the coördinated contractions of the voluntary muscles are dependent upon motor impulses from the central cerebro-spinal ganglionic masses; we are not justified by the experiments of physiologists upon the cerebro-spinal nerves, nor by those directly upon the organic system, in adopting that qualification of the neuro-pathological doctrine, which regards the sympathetic as presiding over, exciting, directing, controlling, and actually generating, as it were, the entire ensemble of phenomena, designated as secretion. Thus, if we take the most noted and extreme examples, as quoted by the most strenuous advocates of the neuro-pathology, and consider them carefully in connection with the facts and principles already established, we will find that there is no broad line of demarcation between the cerebro-spinal and sympathetic nervous systems in their relations to secretion. The relationship of muscular motion, secretion, nutrition and excretion to the cerebro-spinal system, is fully admitted; and as we have shown the tendency of the more recent experiments is to establish a close relationship between the sympathetic nervous system and nutritive actions, secretion and excretion and of the muscular apparatus of the circulatory system, and of the alimentary canal and its associated organs, and to limit the action of the sympathetic nervous system chiefly to the excitation and control of the movement of the muscular apparatus which directly ministers to the organic functions, and to the control of the movements of the heart and of the blood-vessels.

The phenomena following Bernard's celebrated experiment, of irritating the mesial line of the floor of the fourth ventricle, in the centre of the space, between the origin of the auditory and pneumo-gastric nerves, may result, in great part at least, from conditions other than a direct influence of the nerve force on the secretion of grape sugar in the liver, as from excited action of the heart, deranged respiration and afflux of blood into the capillaries of the liver and spleen, in consequence of the irritation of the vaso-motor centres of the nerves supplying the blood-vessel system. The fact that diabetes may be induced artificially, not only by the puncture of the middle of the calamus scriptorius of the fourth ventricle, but also by puncture of the olivary bodies, and of the cervical portion of the spinal cord, shows that the hepatic tissue is not excited to a more energetic discharge of its functions by a stimulus conveyed by the fibres of the pneumo-gastric nerve; but that the increased formation of sugar is due to the result of the irritation of the general vasso-motor centre of the whole body, which Kronecker, of Leipsic, has definitely fixed in the floor of the fourth ventricle, or of one or more of the vasso-motor centres of the cerebro-spinal axis. According to this view, the sympathetic is the agent of transmission, and the phenomena is referable to the same class as those observed when this nerve is divided in the neck.

In section of the fifth pair of nerves, if the various disturbing influences affecting the eye be removed, we have but little else produced by this section than the same injection of the blood-vessels, and increased heat, observed when the sympathetic is divided in the neck. Snellen discovered that if the ears of the rabbit be sewed before the eyes of the animal in which he had cut the fifth pair, destructive ulceration was prevented.

It has also been observed, that in section of the pneumo-gastric, the resulting changes denominated *Pneumonia* and *Pneumonic Inflammation*, are due to the entrance of irritating buccal mucus through the paralyzed rima-glottidis, and a great part of that which had been called pneumonia, was nothing more than such an obstruction of the air cells, and hyperaemia of the blood-vessels, as prevented the proper introduction of oxygen, and elimination of carbonic acid, and ensured the slow poisoning and final death of the animals. Such investigations are not complete without the full consideration and elimination of the poisonous effects of the carbonic acid gas retained in the lungs and blood. In section of the pneumo-gastrics, pneumonia may be avoided, if foreign bodies be prevented from penetrating into the bronchia.

The effects of injuries or sections, therefore, of the vaso-motor system of nerves, appear to be chiefly the contraction or dilatation of vessels, and the arrest of the pulsatile movements which have been seen in minute vessels in many parts of the animal economy, and to the existence of which some physiologists have been inclined to attach much importance, in the regulation of the capillary circulation. These alterations, with the consequent changes in blood supply, which they bring abont, may be the direct results of nerve lesions, or of reflex influences originating in the periphery and transmitted to the central ganglionic centres, and reflected from thence to distant organs, or of the action of poisons introduced into the blood. However caused, the influence of the vaso-motor and so-called *trophic* nerves appear to be limited to the increased or diminished supply of blood, and the alterations of these conditions.

If it be true, that the nervous force is the direct result of the chemical changes of the nervous structures, and is a physical force capable of being transmuted into other modes of force; if it be probable that the nervous force is electricity, or a modified form or state of this physical force; and if it be true that all the chemical actions in the body develop this force, together with heat, it follows as a necessary consequence that the nerves may be capable of influencing secretion, in virtue of the power which this active physical force has of exciting chemical change. Thus an impulse originating in the central masses of nervous matter, or reflected from the circumference, may be propagated by changes of the molecules of the nerves, and reproduce its original effects, by transmission to distant organs. The effects of this transmission would vary according as the nerves terminate in, or are connected directly with the muscular apparatus of the respiratory and circulatory and dynamic apparatus of the living organism, or with the excretory and secretory cells of the various organs. We would thus have an example of chemical change in the periphery of the nerves, and in the various organs, whether muscular or secretory, to which they are distributed, analogous to that which takes place at the terminals of the galvanic battery. Thus in Traumatic tetanus, where there is an exaltation of the acts or force of the ganglionic cells of the gray matter of the spinal axis, constant impulses are sent out to the voluntary muscles and to the sympathetic, in virtue of the nervous connections between the two systems; and thus the ganglionic cells of the sympathetic become in turn excited, and the organs to which this system is distributed, as the kidney, liver and alimentary canal and heart, are in turn affected.

According to this view the function of a nerve would be limited by the nature of the structure in which it originates, and that of the ganglionic centre in which it terminates; but all nervous action would consist essentially in molecular changes of the afferent and efferent nerves. The nervous force being in all nerves the same form of physical force, the functions of each nervous fibre would be determined on the one hand by the functions of the structures to which it is dsitributed, and its relations with the central ganglionic cells.

The tendency of such a theory appears to be the subjection of physical and pathological phenomena to the domain of physical science.

After we have given full force to the arguments commonly urged against the identity of electricity and nervous force, such as the fact that crushing the nerve destroys its power to convey impressions, while it may still conduct electricity, and the difference in the speed with which the galvanic and the nerve currents are propagated, (thus it has been estimated that in the frog's nerves, at a temperature of 52 to 70° F., nerve force moves at a rate of 81 to 126 feet per second, in man in motor nerves, 200 feet per second, in sensory nerves, 110 feet per second, while electricity travels at a rate of 462,000,000 feet per second); it must be admitted that electricity in passing through moistened threads has so low a rate of movement as to render the argument against the identity of the two forces doubtful, and in need of a series of elaborate experiments upon the rates at which the nerves themselves act as electrical conductors; and it must still farther be admitted that nerve force, like magnetism, depends, for its manifestations, upon peculiar physical conditions, and chemical combinations of organic matter, and that at least it may be correlated with electricity, heat, and other modes of physical force.

HYPOTHETICAL DISCUSSIONS AND INVESTIGATIONS CONCERNING THE NATURE OF THE NERVOUS FORCE.

Three hypotheses have been invented to account for the power of the nerves to transmit sensitive and motor impulses and excite secretions: the one which is the oldest and has been the most generally received, is that the brain and nerves are provided with a certain fluid called the animal spirits, which serve as the medium of communication between the different parts of the nervous system; the second supposes that this transmission is effected by means of the vibrations or oscillations of the particles of the nervous matter itself; while the third ascribes the action of the nerves to the operation of electricity.

The hypothesis that the brain and nerves are provided with a certain fluid called the animal spirits, which serve as the medium of communication between the different parts of the nervous system has generally been ascribed to Descartes,* who reduced it to a regular form, and contributed by his authority to its general reception, although traces of this supposition may be found in the writings of the older physicians.

Plato, the preceptor of Aristotle, as we have seen, held that the animal spirits are transmitted from the brain through the whole body by means of the nerves, and in this doctrine he was followed by Galen, Vesalius, Fernelius, and others.

Galen, who refuted the doctrines of Aristotle, as to the functions of the brain, held that the animal spirits are not contained in the ventricles only, but are diffused throughout the whole substance of the cerebrum and cerebellum; he had, however, originally advanced the opinon that they are transmitted from the anterior ventricles to the fourth, through the opening now termed the aqueduct of Sylvius. Although Galen asserted that the function of the nerves consists in transmitting the animal spirits from the brain to the other parts of the body, for the purpose of sensation and motion, still, he does not appear to have been quite certain as to the correctness of his doctrine, as he propounds the following questions: Firstly, whether the nerves contain animal spirits like the cavities of the brain? Secondly, whether this spirit is innate in the nerves, and when a limb is to be moved, is excited only when acted upon by the spirit contained in the cerebrum? Thirdly, whether this spirit be innate in the nerves at all, but rather, when we seek to move a limb, whether it does not flow from the brain into the nerve? Fourthly, whether the matter of the spirits flows into the nerves from the brain in any way? or is it not rather its force, virtue or faculty, just as the substance of the sun remaining motionless, its light-giving property is poured forth into the ambient air? He observes that he only proposes these questions for general discussion, as he was unable to decide absolutely on them.

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* Descartes Tractatus de Homine. Amst., 1677, Sec. 14.

Caspar Bauhin was amongst the first who denied that the ventricles are the laboratory and storehouse of the animal spirits, and who taught that they are generated in the substance of the brain, and dispensed directly from thence through the nerves to the organs of sensation and motion. Caspar Hoffman opposed the ancient doctrine as to the use of the ventricles in preparing and retaining the animal spirits, on the ground, that all the nerves of the body and cerebrum arise from the spinal cord, either within or external to the cerebrum; that the ventricles are lined internally with the pia-mater, which prevents ingress and egress; that since the two superior ventricles open into the third, and the third into the infundibulum, and this into the palate, there is no reason why the spirits might not pass out this way; that the ventricles are not continuous with the nerves, but with the body; and that if it be necessary to the action of the spirits that they be under the control of the mind in the vessels, no force is known which compels them into the straits of the nerves after having entered into the ocean of the ventricles: and finally, that the ventricles have already a function incompatible with that of the spirits, namely, to collect and excrete the effete matters.

These arguments were sufficient to lead many from the doctrines of Galen, and to convince them that the ventricles of the brain are not the factories and storehouses of the spirits, but only established for the collection and expulsion of the effete matters.

Des-Cartes* maintained that the animal spirits were secreted from the brain, by pores opening into the ventricles, and that there accumulating, the slightest disturbance of them excites the soul seated in the pineal gland: and contrarily that the animal spirits in the ventricles are moved by the will acting through the pineal gland, and distributed thence through the nerves to all parts of the body.

The principal ground of this hypothesis, seems to have been the idea that the brain is a secretory organ, an idea which was suggesed by the great quantity of blood sent to it, and by some supposed resemblance in its structure to other secreting glands. Yet, as nothing cognizable by the senses is produced by it, it was concluded that it must secrete something of a subtle or ethereal nature, particularly suited to the performance of the functions which belong to the brain, and which are so unlike those of other material substances. At the time that Des-Cartes wrote, everything that could not be otherwise explained, was referred to the agency of some kind of refined spirit, an idea which appears to have been originally derived from the alchemists, and after being incorporated with the metaphysics of the age, gave rise to a long train of mysticism.

The doctrine of the nervous fluid, or animal spirits, not only became a subject of popular belief, but their existence was assumed by many medical writers as an ascertained fact, and their different diseases and affections were spoken of with as much confidence as if the authors had been treating upon something which was the immediate object of their senses, and with which they were perfectly familiar.

Haller devotes no less than ten pages of his great work, El. Phys., x. 8, 11, 16, to learned discussions respecting the nature of this imaginary agent: inquiries whether it be albuminous, [illegible], and sulphurous aeriform, or ethereal, and concludes that it bears a resemblance to what has been termed the *spiritus rector* of plants, a substance nearly as little understood as the one which it is intended to illustrate.

Romanus, the son, tried to weaken and explode the arguments of Hoffman, and, while he defended the doctrine of Galen, in some measure adopted that of Aristotle: but Wepfer fully answered Roman and [illegible] interred the doctrines as to the use of the ventricles in producing and retaining the animal spirits.

The animal spirits, being ejected from the ventricles, were placed in the cerebral substance: and Marcellus Malpighi, Thomas Willis, Sylvius de le Boe and many other writers, were unanimous in the belief that they are secreted in the cortical substance of the brain; that when secreted they are removed into the medullary substance, and distributed thence through the nerves to the whole body; and this doctrine is maintained by many physiologists and pathologists to the present day. The faculties of the mind, such as perception, imagination and memory, were banished from the ventricles, together with the vital spirits, and were located by some in the solid masses of the brain; by others were affirmed to be properties of the immaterial, rational soul alone, and in no wise dependent on the body[*].

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* Renati Des Cartes Tractatus de Homine et de Formatione Foetus. Quorum Prior Notis Perpetuis Ludovici de la Forge, M. D., Illustratur. Amstelodami, Apud Danielem Elsevirium. 1677, xiv, pp. 24–28.

Tractatus De Mente Humana, Ejus Facultatibus et Functionibus, Nec Non De Ejusdem Unione Cum Corpore, Secundum Principia Renati Des Cartes, Auctore, Ludovico de la Forge, Medicinae, Apud Salmurienses Doctore. Amstelodami. Apud Danielem Elsevirium. [illegible]

It would involve a useless expenditure of time to enter into a detailed account of the various hypotheses propounded and earnestly advocated by Malpighi, Willis, Boerhave, Ruysch, Albinus, Mayow, Mayer, Whytt, Kaauw, Astruc, Haller, Meckel and others, as to the nature of the animal spirits.

The hypothesis of vibration had been imperfectly stated by many of the earlier physiologists, but it was so much detailed and embellished by Hartley, as to be by common consent connected with his name. The hypothesis of vibrations, was laid down by N. Robison, in his treatise on the Spleen, several years before, and by Condillac, in his work on Human Knowledge, two years before Hartley's observations.

According to this doctrine, the action of the nerves consist in a vibration of the particles of which they are composed, by which impressions are transmitted along them, and conveyed to and from the brain, in perception and volition respectively.

This hypothesis embraces two suppositions, viz: either that the particles of the medullary matter itself are the agent, or else, that there is diffused or dispersed through them, a subtle *ether*, which acts the sole or principal part.

Hartley adopted the supposition of the intermediate action of the ether; Dr. Young on the other hand, substituted the electric fluid for the hypothetical ether. Blumenbach admitted the plausibility of the doctrine of a nervous fluid, which is thrown into oscillatory vibrations by the action of stimulants, and argues in favor of the similarity of Nervous Action and the electric influence. Blumenbach even went so far as to say, that by the oscillations of this Ether, Hartley, "very ingeniously explains the association of ideas, and again by the assistance of this, most of the functions of the animal faculties." (Physiol, § 226).

It has been urged in support of the opinion, that nervous action essentially consists in vibrations, that besides light, which is the specific and appropriate cause of vision, the sensation of sight, may under certain circumstances, be produced by other causes, which may all of them be ultimately referred to motion. A smart blow on the eye, friction and pressure upon the ball, and electricity, all produce this effect.

Sir Isaac Newton, concludes his Principia with the following remarkable hypothesis:

"And now we might add something concerning a certain most subtle spirit which pervades and lies hid in all gross bodies; by the force and action of which spirit, the particles of bodies mutually attract one another at near distances, and cohere, if contiguous; and electric bodies operate at greater distances, as well repelling as attracting the neighboring corpuscles; and light is emitted, reflected, refracted, inflected, and heats bodies; and all sensation is excited, and the members of animals move at the command of the will, namely, by the vibrations of this spirit, mutually propagated along the solid filaments of the nerves, from the outward organs of sense to the brain, and from the brain into the muscles." (Principia, Book iii, General Scholium).

We have in the preceding hypothesis not only a statement of the doctrine of vibrations as applied to the nervous system, but also a comprehensive enunciation of the modern doctrine of the correlation of the physical and vital forces.

The Third or Electric Hypothesis of nervous action, is of modern origin, and rests principally upon the observations of Galvani, Aldini, Von Humboldt, Philip, Matteucci, Nobili, Dubois Reymond, and other Continental and English physiologists.

It has been well known from remote antiquity, that certain fish, possess the property of communicating shocks and a benumbing sensation to persons who have incautiously grasped them. It was also observed at an early day that certain affections of the nervous system were benefitted by these shocks, as well as by the force emitted by the load stone and magnets. The remarkable effects of certain fish, have been satisfactorily traced to Electricity, and it is now well established that no real difference exists between the electric fluid thus secreted or excited by these animals, and any of the other modifications of Electricity.[†] When electric phenomena began to excite attention, it was supposed that the fibres of the muscle might be disposed in such a manner as to form a kind of battery, which should produce contractions by its explosions; and after the discovery of galvanism, an elaborate attempt was made by Valli,[‡] of Pisa, to account for muscular action by supposing that the muscles consisted of an arrangement of parts, analogous to that of the elements of the galvanic pile. Valli's speculations on the action of the two metals upon the parts of living animals, led him to as-

[*] Dissertation on the Functions of the Nervous System, by George Prochaska.

[*] Hunter, Phil. Trans., 1773. Dr. John Davy, Phil. Trans. 1832, 1834. Gay-Lussac, Ann. de Chim., lxv., p. 15, joint paper with Humboldt. Colladon, Séances de l'Acad. de Sciences, Octob. 1836. Matteucci, Séances de l'Acad. de Scienes, 1836. Rudolphi, Abhand, du Acad. v. Berlin, 1820, 1821. Walsh, Phil. Trans., 1774. Ingenhouse, Vermischte, Schriften, p. 272, Vienna, 1782. Humboldt, Bonpland and Faraday, Phil. Trans., 1839. Rudolphi, Abhand Acad., Berlin, 1824. Müller, Handbuch der Physiologie des Menchens, i, p. 66, Coblenz, 1837.

[†] Experiments on Animal Electricity, with their application to Physiology, by E. Valli, Brit Crit: March, 1794. Jour. de Phys. t. xii, passim.

sert the identity of electricity and of the nervous fluid, and the same opinion was to a certain extent countenanced by Dr. Young.* Dr. Abernethy, and others. Valli believed the same electric fluid to be secreted by the capillary arteries supplying the nerves, by which it became conveyed to the muscles, which he believed to be always in an electric condition, the interior being negative, the exterior positive. He also noticed the curious fact, that in experiments on frogs, the nerves lose their irritability to the stimulus of electricity at their origin first, retaining it longest at their extremities: and on this hazarded an opinion that probably the distal extremities are really the origin of these structures.

Galvani really discovered, not only the fundamental physiological experiment of Galvanism properly so-called, the contraction of the muscles of the frog when touched with dissimilar metals, but also that of the electricity inherent in the nerves and muscles.

According to Galvani's theory, the muscles chiefly contain the animal electricity. They represent a Leyden jar, their outer surface being charged with negative, their inner with positive electricity. The nerve is the conductor of the jar, and together with the blood-vessels, it supplies the muscles with electricity. The experiments of Galvani, although commenced in the Summer of 1786, were not published until 1791. Volta, in order to determine whether the positive electricity existed in the nerve or in the muscle, discharged through a frog a very slightly charged jar, at first from the spine to the muscles, then in the contrary direction, and finding that contractions resulted in the former case, and not in the latter, he concluded that the current from the slightly charged jar, and that in the frog's limb passed in the same direction, in the first case, and in the opposite direction in the second, and hence, contrary to Galvani's opinion, that the nerve is endured with negative, and the outer surface of the muscle with positive electricity. Subsequent observations by Du Bois Reymond, and others, have established the correctness of this conclusion. Volta, however, abandoned the view of an animal electricity, and instituted those remarkable experiments upon the effects of the contact of heterogeneous metals, which finally led to the discovery of the Voltaic pile in 1799.

Galvani, aided by his nephew, Aldini, produced contractions without the aid of any metal whatever, and performed what may be regarded as the fundamental experiment on the electricity of muscles and nerves. Thus the limb of a frog, prepared according to Galvani's method, is taken, and the nerves are cut off close to their exit from the spine. Then without dipping them into any fluid, and without exposing them to any agent, that could afford any change in them, they are brought in contact with the outer surface of one thigh. This may be done, either by lifting them with a non-conductor and letting them fall again, or by pressing them gently on the surface, so that if possible they touch only a single point of the muscle. On so doing the limb will be immediately convulsed. Galvini even caused the limb to contract, by simply bringing the nerve in contact with the muscle, of another animal, insulated from the limb. Without taking off the skin from the limb, he allowed its nerve to fail upon a piece of abdominal muscle which was lying on a plate of glass, and had no connexion with the frog: the limb was convulsed. Volta explained these contractions by referring them to the action of the electricity generated by the contact of heterogeneous tissues, as in the case of heterogeneous metals. Alexander Humboldt, next investigated this subject, and demonstrated, that muscular contractions may be excited, 1st, by bending the thigh of an animal upon its ischiatic nerve, when the parts were in organic connexion: 2d, by touching simultaneously the crural nerve and the muscles of the thigh with a portion of the crural nerve which had been cut off; 3d, by establishing a circuit between one point of the nerve and some other point of the same nerve by means of some animal tissue. Galvani died December 4th, 1798, and Aldini alone exerted himself for the lost cause of Animal Electricity, and in 1804, published a work of experiments; and animal electricity was neglected for twenty-three years, when in 1827, Nobili demonstrated the Electro-Magnetic Current of the Frog. Œrsted, in 1822, discovered the deflection of the needle by the galvanic current: this led to the construction of the *Galvanometer*. By the judicious application of Ampéres astatic double needle, Nobili discovered that deflections of the needle when present, always indicate that a positive current was passing from the muscle to the nerve, or from the feet to the head in the frog. The current was increased, whenever several frogs were included in the circuit. Nobili referred the current to thermic influences, and to the effects of evaporation, and hence his discoveries did not excite the attention which their importance demanded. In 1836, Becquerel proposed a theory of the Electric fishes, and discovered that at the moment of the shock, the electricity was developed in the brain, and was thence conveyed to the electric organ, to charge the little cylinders of which it is composed. Matteucci seized upon this idea, and still farther elaborated the theory. In 1837 and 1838, Matteucci published experiments with a galvanometer of 2500 coils, and attempted to decompose Iodide of Potassium by animal electricity. These experiments showing that a current may be obtained from any part of the frog, formed the startling point of the delicate

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[*] Lec. v. I p. 740.

and remarkable investigations of the distinguished philosopher, DuBois Reymond, in 1842, who has shown that both the nerves and muscles of living animals are endowed with electricity; which obeys definite laws and relates the two systems to each other. In the Galvanometer employed by DuBois Reymond, in the investigations upon the muscular current, the wire is 3280 feet long and 67-1000ths of an inch in diameter, and coiled 4650 times around the frame. In the more delicate instrument employed in investigations on the nervous current, the copper wire measures 5584 yards, or 3.17 English miles, and is about 55-1000th of an inch in diameter, and is coiled around the frame 24,160 times. Matteucci published his first experiments on the frog current together with those on the Torpedo in the year 1837.

In 1838, he published another paper on the frog-current alone. Matteucci's merit is that he showed that the electro-motive action in the frog, upon which the frog-current depends, is independent of the contact of the muscle and nerve, external to the limb, so that by connecting any two parts of the frog, the back and the eye for instance, a current is obtained. This discovery entirely overthrew the old Voltaic doctrine, and Nobili's theory of thermo-electricity, as well as the idea of any electro-chemical action; moreover, the method of observation described by Matteucci, but afterwards abandoned, contains the germ, the further development of which gave the means of searching deeper into the laws of the electric current in the muscles. This paper, which was reprinted in Paris in 1840, unchanged and without any addition in Matteucci's "Essai sur les Phénomenes electriques des Animaux," as the sixth chapter of the second part of that book, forms the starting point for the researches which Du Bois Reymond has made in animal electricity. He obtained his first results in the Spring of 1842.

The following conclusions have been drawn from the researches of DuBois Reymond.

1. The muscles and nerves, including the brain and the spinal cord, are endowed during life with an electro-motive power, which acts according to a definite law, both in the nerves and muscles, and which may be briefly stated as the law of the antagonism of the longitudinal and transverse section; the longitudinal surface being positive, and the transverse section negative. As the nerves have no natural transverse section, their electro-motive power, when they are in a state of rest, cannot be made apparent unless they have been previously divided. The muscles having two natural transverse sections, may show their electro-motive power without being divided.

2. Every minute particle of the nerves and muscles act according to the same law as the whole nerve or muscle.

3. The currents which the nerves and muscles produce in circuits of which they form part, must be considered only as derived portions of incomparably more intense currents circulating in the interior of the nerves and muscles around their ultimate particles.

4. The electro-motive power lasts after death, or in dissected nerves and muscles after separation from the body of the animal, as long as the excitability of the nervous and muscular fibre; whether these fibres are permitted to die gradually from the cessation of the conditions necessary to the support of life, or whether they are suddenly deprived of their vital properties, by heat, chemical means, etc.

5. In the different contractile tissues, the electro-motive power, is always proportioned to the mechanical power of the tissue. Other animal tissues may, indeed produce electro-motive action; but it is neither so strong as the action of the nerves and muscles nor so regular; nor does it vanish with the vital properties of the tissues; nor does it undergo those sudden variations of intensity or direction, which may be thus stated:—

6. The current in muscles when in the act of contraction, and in nerves when conveying motion or sensation, undergoes a sudden and great negative variation of its intensity. The negative variation of the muscular current is not a permanent one during permanent contractions. It consists rather of a rapidly following succession ot single and sudden variations of the intensity. If any part of a nerve is submitted to the action of a permanent current, the nerve in its whole extent suddenly undergoes a material change in its internal constitution, which disappears on breaking the circuit, as suddenly as it came on. This change, which is called the electrotonic state, is evidenced by a new electro-motive power, which every point of the whole length of the nerve acquires during the passage of the current, so as to produce, in addition to the usual current, a current in the direction of the extrinsic current. As regards this new mode of action, the nerve may be compared to a Voltaic pile, and the transverse section loses its essential import. Hence the electric effects of the nerve, when in the electrotonic state, may also be observed in nerves without previously dividing them.

7. The electro-tonic state of a nerve is the commencement of its electrolysis. The contraction on making the circuit is caused by the nerve passing into the electrotonic state, and that on breaking the circuit by the nerve passing out of this state.

8. Approaching death, and severe injuries of the muscular and nervous tissue, cause other modifications of the electro-motive power of the nerves and muscles, of which some are permanent, and connected with the total extinction of that power, others are only transitory.

The electric phenomena of motor and sensitive nerves are identical. Both classes of nerves transmit irritation in both directions.

If a nerve or muscle be brought into a state of functional activity, either by mechanical, chemical or electrical stimulation, it is found that the current passing through the galvanometer is diminished in intensity, i.e., the difference between the electrical conditions of the longitudinal and transverse sections becomes less. This is known as the negative variation of the nerve or muscle-current. By means of extremely delicate instruments, it has been shown that the negative variation is first felt in those parts of the nerve or muscle which are in the immediate neighborhood of the point where the stimulus is applied, and that it afterwards makes its appearance at points successively more and more distant, while disappearing at the points where it had first appeared. In other words, the negative variation is transmitted with a wave-like motion along the nerve or muscle in both directions from the point stimulated.

The nature of this wave-like motion has been recently carefully investigated by Bernstein, who has determined, both for muscles and nerves, the rate of transmission, the length and duration of the wave. When a muscle is stimulated at any one point, the electrical condition of the muscle at that point is changed, and this changed electrical condition is propagated wave-like in both directions at a rate of [illegible] metres in [illegible], and each portion of the muscle requires [illegible] to go through this changed condition and return to its normal state, and the distance measured in the muscle between a point which is just entering upon, and one which is just leaving this changed condition, is [illegible]. The rapidity of the wave of negative variation in nerves agrees quite closely with the value found by Helmholtz for the rapidity of nerve-force [illegible] metres in [illegible]. This value was estimated by noting how the time elapsing between the irritation of a nerve and the consequent contraction of the muscle attached to it varied according as the stimulus was applied at a distance from or close to the muscle. This close correspondence of the two phenomena in respect to rapidity, together with the fact that the length of the wave of negative variation, i.e., the amount of the electrical change, increases with the intensity of the stimulation, clearly indicates that a very close relation exists between the manifestation of nerve-force and the change in the electrical condition of the nerve, and may even be considered as furnishing a sufficient reason for regarding the latter as a measure of the former.

It has also been finally established by the labors of many observers, that the phenomena of electro-magnetism, magnetism, frictional and animal electricity are one; are governed by the same laws; have the same origin, and produce the same results; and are due to the same force; and it has been shown by philosophers that electricity may be produced by motion; motion by electricity; electricity by magnetism; chemical action by electricity; electricity by chemical action; electricity by heat; heat by electricity; and nervous excitation and muscular motion by electricity.

MUTUAL RELATIONS OF THE MUSCULAR AND NERVOUS FORCES.

The discussion of this subject is necessarily difficult, and to a certain extent, in the present state of physiological science, unsatisfactory. Thus at as late a date as 185[illegible], the physiologist [illegible], after an extended and elaborate examination of the facts and experiments, bearing upon the question of the nature of the nervous force, arrived at the following conclusions:

"(1) That the vital actions of the nerves are not attended with the development of any galvanic currents which our instruments can detect.

(2) That the laws of action of the nervous force are totally different from those of electricity.

(3) To speak therefore of an electric current in the nerves, is to use quite as symbolical an expression, as if we compared the action of the nervous principle with light or magnetism. Of the nature of the nervous principle, we are as ignorant as of the nature of light and electricity; while with its properties we are nearly as well acquainted as with those of light and other imponderable agents. However much these various principles differ from each other, the same question applies to all, namely: are their effects produced by currents of an imponderable matter traveling through space, or by the undulations of a fluid? The discussion as to which theory is correct, in the case of the nervous principle, is at present a matter not affecting the study of the laws of its action, just as the laws of optics, must remain the same whichever theory of the nature of light be adopted."

The doctrine of the unity and correlation of forces, propounded by Dr. J. R. Mayer, shortly afterwards (in 1842), not only led to the recognition of the essential unity of the so-called imponderables, as the chemical forces, heat, light and electricity, and motion, but also slowly but surely forced its way into the theories of physiologists, and led to the reference of all chemical, physical, and vital forces or processes to a single force or power, which originally appeared as light from the sun, and exhibited in inorganic matter and living organisms heat, mechanical motion, chemical change, electricity and nervous and muscular force. The labors of Mayer and Helmholtz, Grove, Faraday, Joule and others, have led to the enunciation of the theory that there is in reality but one single force which runs through an eternally changing round, in dead or inorganic, as in organic living nature. As far as the knowledge of man extends, matter and force, are indestructible; Force changes its form; heat is changed into motion; chemical action developes force in accordance with the amount and character of the matter altered, and in all chemical and physical changes, the resulting power maintains a constant magnitude:—animal heat is dependent upon chemical changes, and the resulting forces, heat and motion, and muscular and nervous force, are dependent upon, and are equivalent to the sum of the power of the simultaneously produced chemical processes.

Professor Owen, in his recent work on *Comparative Anatomy and Physiology*, thus applies these views:

> "Neuricity is not electricity, any more than magonicity; both are peculiar modes of polar force. Any point of the surface of a nerve, is positive in relation to any point of the transverse section of the same nerve, just as any point of the surface of a muscle is positive in relation to any point of the transverse section of the same muscle. Ligature of a nerve arrests the nervous current, not the electric current; a divided nerve connected by an electric conductor, transmits the electric current; but the nervous current excited by stimulous above the section, is arrested by the electric conductor. Neuricity is convertible into myonicity and into other forms of polar force, just as myonicity or the muscular force, may be disposed of by conversion into heat, electricity and chemicity, the latter shown by the evolution of carbonic acid. Molecular change in nervous and in muscular fibre attends the exercise of their respective forces."

One of the most striking facts, with reference to the true nature of the muscular and nervous forces, has been furnished by Comparative Anatomy, viz: that the peculiar instruments found in certain of the lower animals, have the property of accumulating and concentrating the subtle mode of force, applicable to the communication of electric shocks. The currents generated in the electric organs of certain fishes, besides their effects upon the living body, exercise all the other known powers of electricity; they render the needle magnetic; and they decompose chemical compounds and emit electric sparks. Pacini, from a minute comparison of the organs, deduces, that the electricity in the Torpedo, is produced by the dynamic conflict between the two polarities inherent in two sets or degrees of innervation, as it is evolved in the thermo-electric pile, by the conflict of two polarities inherent in two different degrees of temperature; whilst in the Gymnotus, it is produced, as in the Voltaic pile, by the chemical conflict, between the materials of the elements excited by the nervous influence. In the experiments performed by Professor Faraday, on a large living Gymnotus, it was demonstrated by the galvanometer, that the direction of the electric current, was from the anterior parts of the animal, to the posterior parts, and that the person touching the fish, with both hands, received only the discharge of the parts of the organs included between the points of contact. Needles were converted into magnets; iodine was obtained by polar decomposition of Iodide of Potassium; and availing himself of this test, Professor Faraday showed that any given point of the organ, is negative, to other parts, before it, and positive to such as are behind it. Finally in those experiments, heat was evolved by the electric spark obtained.

An analogy has been pointed out by comparative anatomists, between the row of compressed cells, constituting the electric prism of the Torpedo, and the row of microscopic discs of which the elementary muscular filaments appear to consist; the looped termination of the exciting nerve, is common to muscular tissue, and that of the electric organ: and the electric like the motory nerves, rise from the anterior myelonal tracts, and though they have a special lobe at their origin, beyond that origin, in the Torpedo, they have no ganglion. An impression on any part of the body of the Torpedo, is carried by the sensory nerves, either directly, or through the posterior myelonal tracts to the brain, excites there the act of volition, which is conveyed along the electric nerves to the organs, and produces the shock; in muscular contraction, the impression and volition take the same course to the muscular fibres. If the electric nerves are divided at their origin, from the brain, the course of the stimulus is interrupted, and no irritant to the body has any effect on the electric organs, any more than it would have under the like circumstances on the muscles. But if the ends of the nerves in connection with the organ be irritated, the discharge of electricity takes place, just as irritating the end of the divided motor nerve, in connection with the muscle would induce its contraction. If part of the electric nerves be left in connection with the brain, the stimulus of volition, cannot, through them, excite the dischage of the whole organ, but only of that part of the organ, to which the undivided nerves are distributed. So likewise the irritation of the end of a divided nerve in connection with the electric apparatus excites the discharge of only that part, to which such nerve is distributed. The power of exciting the electric action, like that of exciting the muscular contraction, is exhausted by exercise, and recovered by repose; it is also augmented by energetic circulation and respiration; and what is more significant, of their close analogy, both powers are exalted by the direct action, on the nervous centres, of the drug strychnine; its application causes simultaneously a tetanic state of the muscles of the fish, and a rapid succession of involuntary electric discharges.

We propose in the next place, briefly to examine some of the most important facts, illustrating the nature and relations of the muscular and nervous force, without any special reference to their chronological arrangement, in the history of physiological science.

It is now well established that animal life, is not possible without constant chemical and physical changes in the molecules of the body: and since such disturbances are always accompanied with the liberation of electricity, it would not be unphilosophical upon this general view, to infer that electrical currents exist in all living animal structures, and that the intensity of their electrical actions, varies with the amount and character of the chemical and physical actions of the tissues.

The experiments of Brown-Séquard upon the effects of the injection of arterial blood, into the blood-vessels of the arm of a criminal who had been guillotined, and into the vessels of various animals after rigor-mortis had been established, as well as the similar experiment by Professor Stannius, upon the power of arterial blood, not only to overcome rigor-mortis, but also to restore muscular contractility and nervous excitability, prove conclusively that the power of the nerves to transmit impressions, and of the muscles to contract, is due to the chemical actions and reactions between the oxygen of the blood, and the elements of the muscles and nerves.

The Italian philosopher Matteucci, has shown that during muscular contraction, the consumption of oxygen, and the exhalation of carbonic acid are increased, in accordance with the amount and length of the muscular actions. It is reasonable therefore, to refer the muscular force to the chemical actions established within the muscular structure; and it appears to be probable that the chemical actions, are first transformed into electricity, or some modification of the force, to produce this contraction.

Helmholtz, in like manner has shown, that muscular action is always accompanied by a chemical change in the composition of the acting muscle.

Physiological experiments of the greatest delicacy and accuracy, have established the fact, that electrical currents, circulate in all tissues in which active nutrition is carried on, and that the electro-motive force, is strongest, and at the same time, is capable of the greatest and most sudden variations in intensity and direction in the nerves and muscles; that there exists, both in the muscles and in the nerves of all animals a natural electricity, which is manifested under the form of closed currents, circulating along the muscles or the nerves of the animals, and of which we can collect a very small derived portion by the assistance of delicate instruments, and the presence of this free electricity is subordinate to the state of life of the animal, and disappears with the loss of vitality in the tissues.

DuBois Reymond, by a series of experiments of wonderful delicacy and accuracy, and variety, has established the following important physiological facts and principles: the muscles and nerves, including the brain and spinal cord, are endowed during life with an electromotive power, which in both, acts according to the same definite law, the longitudinal surface being positive, and the transverse section negative: every particle of the nerves and muscles, act according to the same law as the whole nerve or muscle: the electric currents in the nerves and muscles show in some instances, variations of intensity and direction, so sudden that it appears impossible to account for them by any change of large heterogeneous elements, or in any other way than by assuming corresponding changes of position in almost infinitely small centres of action, hence, nervous and muscular electrical currents manifested and measured by the instruments of the experimenter, must be considered only as derived portions of incomparably more intense currents circulating in the interior of the nerves and muscles around their ultimate particles: the electric state of both nerves and muscles, must therefore be compared to that of closed circuits: in the different contractile tissues, the electro-motive power is proportional to the mechanical power of the tissues, and whilst other animal tissues may produce electro-motive action, it is neither so strong nor so regular as the action of the nerves and muscles, nor does it vanish with the vital properties of the tissues, nor does it undergo the sudden variations of intensity and direction which characterize the electro-motive force of the muscles in the act of contraction, and of the nerves when conveying motion and sensation; when the nerves are no longer able to cause sensation or motion, or soon after, the electric current appears very feeble, or its normal direction becomes inverted, the negative surfaces being now positive, and the positive surfaces negative, and finally, the electrical phenomena in the nerves disappears at the same time with the vitality; the muscular current continually decreases after the death of the animal, and after the separation of the muscle from the body; the electric power of a muscle is always proportioned to its contractility, inasmuch as those agents which do not influence its contractility also exert no influence on its current; the diminution of the muscular current after death, is proportional to the diminution of the excitability of the muscle; both the electro-motive force, and excitability have the same termination, that is, the rigor-mortis, caused as Brücke has proved, by the coagulation of the fibrin contained in the muscles, external to the blood-vessels; the current when once it has gone in consequence of the rigor-mortis, never returns; limbs in a state of decomposition or after the relaxation of the rigor-mortis, no longer possess any electro-motive force. DuBois Reymond considers therefore, that the phenomena of muscular and nervous currents can only take place in the living tissues.

Another electro-physiological law of great interest, and especially in its relations to certain diseases of the nervous system, as Tetanus, has been established by DuBois Reymond, for the motor nerves, and may be expressed thus: the motor nerves are not excited by the absolute amount or density of the current, but merely by the *variations* which occur in the density of the current, from *one instant* to the other, and the more considerable the variations in the density of the current, the greater the physiological effects. It results from this, that unstable conditions of the closed muscular and nervous currents dependent upon derangement of the chemical and physical properties and actions of the molecules of the muscles and nerves would be necessarily attended by deranged muscular and nervous actions; variations in the density of the currents circulating in the motor nerves, may be attended with either exaltation or depression, or alternate exaltation and depression of muscular action.

We will examine, in the next place, the important question, whether *contractility*, be inherent in the muscles, or whether it be entirely the result of a force communicated to the muscles by the nerves.

The controversy with reference to the inherent contractility of muscle, independent altogether of nervous influence, carried on from the time of Haller to the present day, may now be considered as settled in the affirmative.

The experiments of Bernard, Kölliker, Althus and other physiologists with woorara, demonstrating that this poison kills the motor nerves without destroying the power of the muscles to contract; the microscpical observations of Dr. Wundt, showing a difference between the contractions of muscular fibres when the electrodes are directly applied to the muscles or to the nerves; and lastly the important microscopical observations of Mr. Bowen, showing that the fragments of the elementary fasciculi of voluntary muscle, which he had isolated from every extraneous tissue, whether nerve or vessel, contract when excited by mechanical irritation, establish the existence of inherent muscular contractility, independent of nervous excitability.

That muscles do not derive their state of tone or power of contractility from the cerebro-spinal and sympathetic nervous systems, and especially from the spinal cord, but possess within themselves all the conditions necessary for the generation of their proper force, is manifest from the following considerations: In chemical composition, the muscles resemble more nearly the contractile element of the blood, viz: *fibrin*; the anatomical and mechanical arrangement of muscles adapts them for contraction and expansion, whilst the large supply of blood which they receive furnishes the essential elements and conditions for the continuous maintenance of those chemical changes which develop the muscular force; the mechanism of muscular contraction may be seen by the microscope, even in detached portions of muscular fibre entirely deprived of nerves; muscles dissociated from the nervous centres by the section of all the nerves distributed to them, retain their power of contraction for a considerable period, long after the nerves which sink in them have lost their excitability; the irritability of the nerves and muscles may be destroyed or suspended, independently of each other, by the action of certain poisonous substances, which have the power of destroying the irritability of the muscles and nerves by a direct action upon their tissue.

The results obtained by Dr. E. Harless, (Müller's Archiv., 1847, p. 228); from experiments undertaken for the purpose of determining the relation in which the nervous influence stands towards the irritability of muscular tissue, establish that the functional integrity of the nerves ramifying in the muscles, is not necessary for the excitement of muscular contractions, and that the muscles themselves are susceptible of the direct action of stimuli. Having exposed rabbits to the influence of the vapor of ether, until they were so far overpowered by it that no movements of their bodies could be excited even by means of galvanism, they were killed by opening the carotid arteries, and the brain and spinal cord exposed. On galvanizing these nervous centres, not the slightest movement of the body resulted, but when the galvanic stimulus was applied to the muscles of the trunk, violent contractions at once ensued. Galvanizing the crural nerve, produced not the slightest action of the muscles of the corresponding leg, but these muscles were thrown into immediate contraction when the stimulus was appiied directly to themselves. Similar results were obtained by galvanizing the nerves and then the muscles of other parts of the body. The result in all cases appeared to point to the conclusion that the muscular tissue possesses within itself an inherent power of contraction independent of the influence of the nerves distributed to it; for, in these experiments, the nervous system was so far overpowered by the ether that no amount of irritation of it could excite muscular contractions, while these contractions, were at once induced when the irritation was applied to the muscular tissue itself.

M. Bernard has demonstrated that the irritability of the muscles may be destroyed, while that of the nerves remains unaltered, and that the sensitive and motor filaments may each be paralyzed independently of each other. Thus, when the frog's leg has been prepared and separated from the body, with the sciatic nerve attached, the muscles contract whenever the nerve is irritated, the irritability being manifested in this experiment only through that of the muscle, and that of the muscle being called into action through the nerve. If a frog's leg be prepared as above, and the animal be poisoned by woorara, the poles of a galvanic battery applied to the nerve will produce no effect, showing that the nervous irritability has ceased to exist, but if the galvanic discharge be passed directly through the muscles, contraction at once takes place: the muscular irritability has survived that of the nerves.

Sulphocyanide of Potassium produces paralysis of the muscular tissue, while the nerves of the same part retain their irritability; woorara destroys the irritability of the motor nerves without affecting that of the muscles, and at the same time the sensitive fibres retain their power of transmitting impressions; in poisoning by strychnine the sensitive filaments of the nerves are paralyzed, while the motor filaments and muscles retain their irritability.

The researches of Bernard have been confirmed by a series of experiments with woorara and conüne, undertaken by Kölliker. According to Kölliker, the action of conüne is nearly equal to that of woorara.

Dr. J. Althus has obtained similar results with woorara, and he gives the following as the experiment which best shows that it is only the motor nerves which are killed by the poison. The crural artery and veins are closely tied up on one side, so that the circulation of the blood in the limb is stopped. The animal is then poisoned by inserting a small quantity of woorara under the skin. If galvanization of the motor nerve be practiced, a short time afterwards, it becomes evident that all the nerves have lost their integrity, with the exception only of the crural nerve of that side where the vessels have been tied: this nerve, when galvanized, sets the muscles in play. But if the electric stimulus be directed to the muscular substance itself, contractions may be obtained in all the muscles; and the contractile power of those muscles, the nerves of which have been poisoned, will last even longer in those which have not been, in consequence of the stoppage of the circulation of the blood in the latter.

The following are the experiments with Sulphocyanide of Potassium and Strychnine, as detailed by Dr. John C. Dalton, in his valuable Treatise on Human Physiology:

In a living frog, the sciatic nerve is exposed in the back part of the thigh, after which a ligature is passed underneath it and drawn tight around the bone and the remaining soft parts. In this way the circulation is entirely cut off from the limb, which remains in connection with the trunk only by means of the sciatic nerve. A solution of sulphocyanide of potassium is then introduced beneath the skin of the back in sufficient quantity to produce its specific effect. The poison is then absorbed, and is carried by the circulation throughout the trunk, and the three extremities, while it is prevented from entering the limb by the ligature which has been placed around the thigh. Sulphocyanide of potassium produces paralysis, by acting directly upon the muscular tissue. Accordingly a galvanic discharge passed through the limbs, which received the poison by absorption, produces no contraction in them, while the same stimulus applied to the limb, the blood-vessels of which had been tied, but which communicated freely with the sciatic nerve, is followed by a strong and healthy reaction. But at the moment when the irritation is applied to the poisoned limbs, though no visible effect is produced in them, an active movement takes place in the healthy limb. This can only be owing to a reflex action of the spinal cord, originating in the integument of the poisoned limbs, and transmitted through sensitive and motor filaments through the cord to the sound, unpoisoned leg. *While, therefore, the muscles of the poisoned limbs have been directly paralyzed, the nerves of the same parts have retained their irritability.* If a frog be prepared in a similar manner and poisoned by the introduction of woorara beneath the skin of the back, when the limb, which has been separated by the ligature around the blood-vessels, is irritated, its own muscles react, while no movement takes place in the poisoned limbs: but if the irritation be applied to the poisoned limbs, reflex movements are immediately produced. In the poisoned limbs, therefore, while the motor nerves have been paralyzed, the sensitive filaments have retained their irritability.

If a frog be poisoned with strychnine, introduced underneath the skin in sufficient quantity, death takes place after general convulsions, which are due to an unnatural excitability of the reflex action. Tetanus and poisoning by strychnine, both act in the same way, by heightening the irritability of the spinal cord, and causing it to produce convulsive movements on the application of external stimulus. It has been observed that the convulsions of Tetanus are rarely, if ever, spontaneous, but they always require to be excited by some external cause, such as accidental movement of the bed-clothes, the shutting of a door, or the sudden passage of a current of air. Such slight causes of irritation, which would be entirely inadequate to excite involuntary movements in the healthy condition, act upon the spinal cord when its irritability is heightened by disease in such a manner as to produce violent convulsions. Similar appearances are to be seen in animals poisoned by strychnine. This substance acts upon the spinal cord, and increases its irritability without materially affecting the functions of the brain. Its effects will show themselves, consequently, without essential modification after the head has been removed. If a decapitated frog be poisoned with a moderate dose of strychnine, the body and limbs will remain quiescent so long as there is no external source of excitement; but the limbs are at once thrown into convulsions by the slightest irritation applied to the skin, as, for example, the contact of a hair, or a feather, or even the jarring of the table on which the animal is placed. That the convulsions in cases of poisoning by strychnine are always of a reflex character, and never spontaneous, is shown by the following fact, first noticed by Bernard, viz: That if a frog be poisoned after division of the posterior roots of all the spinal nerves, while the anterior roots are left untouched, death takes place, as usual, but is not preceded by any convulsions. In this instance the convulsions are absent, simply because, owing to the division of the posterior roots, external irritations cannot be communicated to the cord. In poisoning by strychnine, however, the unnatural excitation of the reflex action is followed by a paralysis of sensibility, so that after death no reflex movements can be produced by irritating the skin, or even the posterior roots of the spinal nerves. But if the anterior roots, or the motor nerves themselves be galvanized, contractions immediately take place in the corresponding muscles. In this case, therefore, the sensitive filaments have been paralyzed, while the motor filaments and the muscles have retained their irritability.

Such facts justify the conclusion, that there is no direct dependence of the muscles upon the nervous system for the development of their proper force; and that this force results from the chemical changes involved in the healthy nutrition of the muscles; the chief influence of the nervous system therefore upon the muscular system is by the disturbance of the electrical condition, and by an influence upon the nutrition of the muscle through the variation of the amounts of blood circulating through the muscular structures. It has been shown by numerous experiments, that if the nerves of a muscle be divided, and it be left to itself, its nutrition fails gradually, and with this change in the chemical actions, the contractility diminishes; but, if on the other hand, the muscle be daily exercised by galvanic stimulus, both its nutrition and its contractility remain unimpaired. Longet found that when a motor nerve is separated from the nervous centres, in a living animal, it will lose all trace of excitability on the fourth day after its connection has been severed. After the fourth day, mechanical, chemical or electrical stimuli, will fail to produce muscular contractions, if they be applied to the free extremity, or the branches of the nerve; on the contrary, a muscle, the motor nerve of which has lost its excitability, will visibly vibrate under the influence of a stimulus, even twelve weeks after the section of the nerve has been made. From this Longet inferred, that the motor nerves are not the only excitors of muscular motion: that muscular irritability is independent of the motor nerves; and depends essentially upon the supply of arterial blood, a condition necessary not to impart or communicate to the muscles the property in question, but only to maintain in the muscular tissue, the nutrition which keeps up the vital properties of all the tissues of the animal body. Dr. John Reid, obtained similar results, by insulating the hinder extremities of frogs, from their nervous connections with the spinal cord; and then daily exercising the muscles of one of the paralyzed limbs, by a weak galvanic current, while the muscles of the other limb were allowed to remain quiescent. At the end of two months, the muscles of the galvanized limb retained their original size and firmness, and contracted vigorously, while those of the quiescent limb had shrunk at least, one-half of their former bulk, and presented a marked contrast to those of the galvanized limb. But even at the end of two months, the muscles of the quiescent limb had not lost their contractility.

Whilst such experiments therefore, demonstrate on the one hand, that the muscles develope their own mechanical force, on the other hand, they demonstrate, the close analogy, if not absolute identity between nervous force and electricity.

The nerve possesses of itself a certain electric state, which is modified by long excitation exercised upon the nerve; the muscle has likewise a natural electric state, which is modified every time there is a contraction; in the absence of excitation exercised upon the nerve, and of contraction produced upon the muscle, there must necessarily be established a certain electric equilibrium, which consists in the circulation of internal electric currents, in relation with the chemical phenomena that are accomplished in living muscle.

M. Amici, by means of his compound microscope, has succeeded in forming an idea of the structure of elementary muscular fibre, and of the mechanism of muscular contraction. According to this observer, a simple muscular filament, is composed of a series of discs, excessively thin and near together, connected with each other by means of a great number of infinitely small threads, going from the circumference of one of the discs, to that of the other; the discs themselves, are as it were, rings, the circumference of which being more compact and resisting, serve as the attaching point to the threads, whilst their central point is filled with a soft matter, analogous to that which is found in infusoria, and which seems to be the matter of which the muscle is formed. When contraction takes place, the threads are seen to enter inwardly, forming a broken line, so as to bring about the approximation of the discs, which instead of remaining the two bases of a cylinder, seem to be the bases of two truncated cones, opposed by their smaller bases. There follows from this change, a shortening of the entire fibre. De La Rive, reasoning upon these facts, thus explains the cause and mode of contractions:—In the state of rest, and under the influence of vital force, the particles of each disc, or ring, have their negative poles turned interiorly, and their positive poles exteriorly, but under the action of any cause whatever, the particles makes a demi revolution, which causes their negative poles to turn downward, and their positive upward, or reciprocally; it follows then from this, that these particles, having their contrary poles placed all near the others, in the same rectilinear direction, which is the direction of the length of the fibre, they mutually attract each other, which causes the discs to approach, as actually takes place in contraction.

In endeavoring to explain the mode ot action, and nature of nervous and muscular force, and the relations of the nervous to the muscular system, by the aid of the facts and laws already recorded, and which as we have before stated, have been established by actual experiments of the greatest delicacy and accuracy, we shall avail ourselves of the formulation, extension and perfection of the theory of DuBois Reymond, by the philosopher De La Rive, as presented in various parts of his great work on Electricity.

In order to explain the electric state of the muscle, it must be admitted that each organic molecule of which the muscular bundle is composed, is naturally electric, and that it possesses the two electricities in a free state. M. DuBois Reymond conceives, that these molecules, which may be of any form, but which he supposes to be spherical, have each a positive equatorial zone, and two negative polar zones. He supposes, moreover, that they are so arranged, that the diameters which pass through the negative poles of each are parallel to each other, and to the axis of the muscular bundle; he terms the molecules *peripolar*. De La Rive, is disposed to believe that the phenomena may be very well explained by assuming that the organic molecules have but two electric poles, one positive and the other negative, an hypothesis which De La Rive, has already set forth for inorganic molecules; only on the other hand, this philosopher is led to suppose, as indeed M. DuBois Reymond is obliged to do, in order to explain the electrical phenomena of the muscle, that by the effect of life, these molecules assume a peculiar arrangement. They are not indeed, arranged as in an inorganic substance abandoned to itself, so that there is established an electric equilibrium, by the effect of the mutual neutralization of all the molecular electricities, but so that in each transverse section of the muscular bundle, the positive poles of the molecules are turned outward, and the negative poles inward. The positive and negative electricities of the molecules of each section, which radiate from the centre to the circumference, neutralize each other, except the positive, of those which are at the circumference, and the negative of those which are at the centre. But these two free electricities are reunited by the exterior surface of the muscle, forming currents of which we collect only a derived portion in the experiments in which we cause the transverse and longitudinal sections of a muscle to communicate together, or two dis-symmetrical points of the same section. Such then, would be the arrangement of the molecules in each elementary muscular bundle, whence would naturally result a negative electric state to all the points of the two bases or extremities of the complete muscular bundle, and a positive state to all the points of the longitudinal surface. The electrical state of the artficial sections, whether transverse or longitudinal, would evidently be also, the consequence of the same distribution of the particles.

The nervous current is subject to the same laws as the muscular current; we may therefore assimilate these two currents, and consider the former as being, as well as the latter, a derivation of the current that is established in the nerves, and in the conductors with which it is surrounded, by the effect of the electric polarity of the nervous polarity of the nervous particles, and of the arrangement which they assume under the influence of the vital force. With regard to the electro-motive power of the nervous particles, it is difficult to appreciate it: but we may affirm that, under equal circumstances, the nervous current is in no way inferior in force to the muscular current. The electro-tonic state which the nerve assumes, which renders it fitted for conveying to the muscles, or to the nervous centres, those modifications that we recognize under the form of motion or sensation, is due to a molecular polarization of the nerve, analogous to that which is determined in all conducting bodies, by the effect of the passage of an electric current. This polarization consists in the fact, that the nervous molecules, endowed naturally, like those of the muscle, with two electric poles, turn all their positive poles on the side towards which the current is directed, and their negative on the side whence it comes. This explanation, which De La Rive borrows from Bu Bois Reymond, does not require that we should admit, with the latter philosopher, in the nerve, any more than in the muscle, the existence of peripolar molecules, which he supposes to be formed in the nerve, each from the juxtaposition of two bipolar molecules. De La Rive considers that it is enough to suppose that these molecules are bipolar; and that under the influence of the vital principle, they are in the nerve, as in the muscle, arranged in such a manner that their positive poles are turned exteriorly, and their negative interiorly. This arrangement explains for the nerve, in the same manner as for the muscle, the manifestation of the current proper, called in this case nervous current.

A nerve excited by any means whatever, and an electric current applied directly, acts in the same manner upon a muscle. It is therefore probable that it is by a modification in its natural electric state, that the nerve acts, when, by virtue of an excitation arising from the brain, or from the muscle, or from an exterior cause, it produces motion or sensation.

The following explanation has been given of this mode of action: The nerve possesses a nected with a difference in the state and in the nutritive power of these tissues, so that the positive element of the organic pair would be always represented by the part of the tissue whose nutritive power is the stronger. As is apparent, M. Matteucci, agrees with De La Rive, in this respect, that it is from the vital force that he makes animal electricity depend in the first instance; only according to him, it is only indirectly in compelling nutrition to operate that the nerves, intermediate between vital force and the muscles, would develope electricity, whilst according to De La Rive, the action would be more direct; the transmission of vital action from the nerves to the muscles being brought about by the very electricity with which the nerves are primarily endowed.

De La Rive, does no way contest the part of chemical action in the production of animal electricity; but it is from it that he makes the first origin of this electricity to proceed, which appears to be pre-existent to the causes that determine its manifestation, as well in the living organism as when inorganic matter is in question.

If then the propagation of nervous action, be due to a natural and progressive modification in the arrangements of the particles by virtue of their electric polarity and the closed circuits of electricity in the quiescent state; the two most formidable objections to the identity of nervous force and electricity, viz: the arrest of the nervous current by a ligature, and the slow rate of the transmission of nervous force, as shown by the ingenious experiments of M. Helmholtz and DuBois Reymond, receive an easy explanation. The ligature destroys the natural arrangement of the molecules of the nerves, upon which the transmission of the weak nervous current depends, and transmission of nervous excitation through the nerves necessarily requires a sensible duration longer than that of a simple and more powerful extraneous electric current, because of the progressive alteration and re-arrangement of the molecules composing the nervous and muscular structures, during the transmission of sensation and motion and the performance of mechanical acts.

We have thus presented, from various portions of his great work on Electricity, and in the very language of its learned author, the theory of De La Rive, which embraces with slight modifications, the theory of DuBois Reymond, and rests for its truth upon the extensive researches of this accurate and skillful observer, and also upon the results of the labors and experiments of Galvani, Volta, Aldini, Humboldt, Matteucci, Nobili, Marianini and others.

If this theory be true, it results, that the nervous and muscular phenomena of certain diseases, as tetanus, must be due to disturbances in the electric condition and relations of the molecules of the nerves and muscles.

If in the state of health, the molecules of the nerves and muscles are restrained in a particular arrangement by the vital force, and if under the action of the will, or of other causes determinining muscular contraction or relaxation, this arrangement is modified so as to become similar to the condition of a conductor transmitting an electric current, it is most probable that when the derangement of the molecules is caused by almost every cause however slight, capable of disturbing the electric equilibrium, and even beyond all control of the will, and even so powerful in its effects, as to rend asunder the muscular structure, there is either a want of proper action of the vital force in preserving the mutual and definite relations of the molecular forces, or an undue activity in the molecular changes in the nerves and muscles.

We will demonstrate in the Medical Memoirs, that during the active stages of Traumatic Tetanus and Fever, there is an increased chemical change of the nerves and muscles; we must conclude, that tetanus is due not only to a disturbance in the electrical conditions and relations of the nerves and muscles, but chiefly to a great augmentation of the intensity of the electrical actions in both nerves and muscles. This view is farther sustained by the fact, that the contractions of the muscles in tetanus, are far more violent and prolonged than those of health, excited by any cause whatever, internal or external, by the will or by mechanical stimuli, so violent in fact that the muscles are frequently ruptured, and that too, against no other points of action than the long bones, and in no other action than in that of simple involuntary contractions; and by the equally striking fact that a continuous current of electricity, may when passed in a certain direction, relieve the spasm of tetanus. Nobili discovered that frogs affected with violent tetanus, became quiet if a continuous current was sent through their limbs in a given direction, while the tetanus continued undisturbed if the current moved in a contrary direction. M. Matteucci, observed similar effects of continued currents upon frogs tetanized by strychnia, when they were subjected to the action of a continuous galvanic current, the tetanus disappeared very soon, and did not return, although the frogs died afterwards from the effects of the strychnia. M. Nobili concluded from his electro-physiological researches upon tetanus in the frog, that it might be possible that the action of an electric current guided in a given direction might serve to calm if not to cure tetanus in man. Matteucci, actually tested the therapeutic effect of the continuous current in traumatic tetanus. In conjunction with M. Farina, he caused a continuous current from thirty to forty pair of plates, to pass along the spinal marrow of a patient suffering with traumatic tetanus, in consequence of gun-shot wound of leg, in the direction from the sacrum to tion, which is the cause of it, last only an instant, on account of the electricity proper of the fibre, and the particles replace themselves at their former distance. However, there is an important difference to be noted. When muscular fibre is contracted by the effect of a continuous electric current applied either to its nerve, or immediately to itself, the contraction endures, it is true, but for an instant; but the particles of the muscle, while still regaining, by virtue of elasticity, their former relative distance, preserve their electric poles turned in the direction of the length of the fibre; it is only at the moment when the electric current ceases to circulate, that the electric poles of the particles replace themselves in their normal position, and this return is accomplished by a new displacement of the particles, and consequently by a new contraction. The reason why there is contraction only at the establishment and at the rupture of the current, is because it is only at these two moments that there is a semi-revolution of the particles of the muscle. When the current, instead of being continuous, is discontinuous, then there is so rapid a succession of displacements, and returns to their primitive position of the particles of the muscle, that the contraction seems to be permanent, *which constitutes tetanus;* however, as may be seen by the galvanoscopic frog, the contraction is really intermittent.

It remains to know, how it may result from a modification in the electric state of the nerves, that any particular muscle is modified so as to produce contraction. It would be necessary in order to solve this question, in a somewhat satisfactory manner, to know better than we do now, the manner in which the nerves terminate, and in which they are ramified in the muscles.

It appears to De La Rive, as probable, that each elementary nervous filament abuts upon an elementary fibre; then it is not astonishing, that if this nerve is polarized by a cause of excitation, it brings about the polarization of the muscular fibre upon which it abuts; in this case the fibre enters into the circuit of the nerve, and it must suffer contraction; as when it is traversed immediately by an artificial electric current. We shall find then the same phenomena; in particular, that the contraction lasts but an instant, providing the nerve is not tetanised, which causes the muscle itself to be so also. In sensation, it is the muscle whose normal electric state is disturbed, which polarizes the nerve, so as to act upon the brain. In both cases equally, it is not astonishing that everything that alters the molecular constitution of the nerve prevents its polarity being established, and consequently arrests the transmission of motion and sensation. De La Rive, conceives it to be very important, in order to found these explanations upon more solid bases, and in order to be able to give them more precision, that we should succeed in determining better than has been done, the mode of communication of the nerve and the muscle. What appears to this observer, to be eminently probable is, that in muscular contraction, as in the transmission of sensation, the reciprocal action of the nerve and the muscle is brought into operation at the very extremity of the nerve itself, and not all along its course through the muscle.

De La Rive, concludes from the detailed study just given, that the body of a living animal may be regarded as the seat of an innumerable multitude of electric currents, the greater portion of them having only local circuits: it is the derived portion of these currents that we succeed in collecting by experiment. But when by the effect of the will, or of another cause acting directly upon the nerve, its electric state is modified, the corresponding local current is transformed, if not entirely, at least in part, into a current, the more considerable circuit of which comprehends then, the nerve and the corresponding muscle; and the effects that we have been pointing out result from it.

De La Rive, is led to assume that the agent, by means of which all nervous action is excited is electricity; not an electricity created at the very moment when the nerve acts, but pre-existing in all the organic particles, as it pre-exists in all the particles of inorganic and organic matter. This philosopher, is moreover, forced to admit, that, under the influence of life, these particles are arranged in an altogether special manner, and which permits of the accomplishment of the organic functions; so that life cannot be considered as a consequence of the electric nature, and of the arrangement of the particles, but must, on the contrary, be regarded as the cause of their mode of grouping, and consequently indirectly of the phenomena that results from it. Let life indeed be taken away, and the particles, still preserving their electric properties—that is to say, their polarity—are grouped quite differently, so as to obey the conditions of equilibrium of the forces that are proper to them, and no longer present aught, but the ordinary phenomena that inorganic matter offers us.

M. Matteucci, while still recognizing that organic currents are not due to any exterior chemical action whatever, considers that we must attribute them to the chemical actions of the living organism. It would be according to him, in the chemical action that must exist between muscular fibre, properly so-called, and arterial blood in contact with it, and consequntly in the nutritive life of the tissues, that we ought to seek for the cause of these currents. It would be thus inherent in the state of the life of the organic tissues, and constantly connected with a difference in the state and in the nutritive power of these tissues, so that the positive element of the organic pair would be always represented by the part of the tissue whose nutritive power is the stronger. As is apparent, M. Matteucci, agrees with De La Rive, in this respect, that it is from the vital force that he makes animal electricity depend in the first instance; only according to him, it is only indirectly in compelling nutrition to operate that the nerves, intermediate between vital force and the muscles, would develope electricity, whilst according to De La Rive, the action would be more direct; the transmission of vital action from the nerves to the muscles being brought about by the very electricity with which the nerves are primarily endowed.

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DuBois Reymond, has remarked, that in a tetanized limb of a frog, the gastrocnemius muscle became quiet, as soon as the sciatic nerve was laid upon the tendon of the muscle; that is, if the *inverse* current proper of the muscle was made to pass through the nerve; but that tetanus continued unchanged, when the nerve touched the flesh of the muscle, that is, when the *direct* current proper of the muscle traversed the nerve.

Professor Ecklard, of Giessen, has been led by an important research to the conclusion, that if a constant continuous current of a certain intensity and direction be made to pass through a nerve, the excitability of this nerve will be so much diminished that any mechanical, chemical or electrical stimulus, which would otherwise bring about a contraction of the muscle, will no longer be able to induce such contraction, so long as the galvanic current continues to traverse the nerve; but that as soon as the circuit has been opened again, contractions will be brought about if the nerve be excited anew. We have also in experiments upon the lower animals, produced powerful tetanic spasms and even death by passing a strong interrupted current, both from the magneto-electric and galvano-electric machines. along the course of the spinal cord. The interrupted current passed in sufficient intensity up and down the spine, produces effects similar to those of tetanus and of strychnia in poisonous doses.

In Traumatic Tetanus, the mind is unaffected, and as a general rule the temperature is not elevated as in fever, and the sudden and violent muscular contractions cannot be controlled by any force of the will; and in this state, we have a complete demonstration at the hand of nature, that the nervous and muscular systems constitute peculiar physical apparatus. worked by physical force. In tetanus we have such an exaltation of the functions of the spinal system of nerves, that the reflex actions are performed with great intensity and entirely beyond the control of the will; and the theory appears to be reasonable, that the nervous and muscular phenomena are due to disturbances in the electric condition and relations of the molecules of the nerves and muscles. It is clear from the phenomena manifested in tetanus, that sensation and motion, and the force by which they are excited, are wholly distinct from mental or intellectual acts. Ordinarily in health, the mind acts through the nervous system, receiving inpressions and transmitting impulses, by means of the nervous force which depends for its manifestation upon the molecular arrangement and forces of the nervous system; in such a state as that of Traumatic Tetanus, or as that produced by certain drugs, as strychnia, the physical force of the nervous system. is developed in far larger amount than necessary, and the actions become like those of a machine heavily charged with electricity. If the nervous and muscular forces, were not, purely physical forces, we could have no such manifestations as that of tetanus.

We conclude this introduction by some general observations upon the

PHYSICAL AND INTELLECTUAL CONSTITUTION AND RELATIONS OF MAN.

The progressive study of the phenomena of the universe known to the human mind finds the last most comprehensive, complicated and typical work in man, governed by the mechanical, astronomical, physical and chemical laws of inorganic bodies, and comprehending within himself all organic nature—composed of inorganic elements, prepared and grouped into definite compounds in the vegetable kingdom, by the combined actions of the forces of matter and of the sun, under the guidance of the vital principle—endowed with a body perfect in its mechanical structure, and in the arrangement of its parts, with the size of its organs, the strength of its muscles and bones, and the vigor of its forces constructed and arranged with exact reference to the force of gravity, the size of our globe, and its relations with the sun and all other worlds in the universe; worked by forces the resultants of the chemical changes of those substances, which in the vegetable kingdom have been elevated into a state of force by the action of the sun; unable to create or annihilate any force, any more than to create or annihilate matter; endowed in common with all vegetables and animals with vital force, and arising from the same common origin, the cell, and like plants and animals passing through various stages of development; possessing in common with all animals, and in contradistinction to vegetables, a nervous system, endowed with special sensibilities relating the various organs and apparatus to each other, in such a manner, that amidst an innumerable number of complex actions, unity and harmony result; and relating the mind with the exterior world in such a manner, that it is capable of obtaining a view of its ever-changing relations endowed with intellectual and moral faculties capable of receiving impressions through the nervous system, and of exciting the forces by which they are surrounded, and of directing and controlling them, so as to act upon the exterior universe—formed by the Eternal in His own image, for purposes stretching into infinite ages.

It is a universal law, that the component parts of the Universe have not in themselves the entire aim or reason of their existence—every form of matter is, definitely related to every other form of matter upon the face of the globe, and the combinations of these various relations and actions and re-actions of terrestrial masses, form the essential conditions for the manifestation of the designs of the Creator.

As a man is composed of inorganic elements, and governed by all the laws, physical, chemical and astronomical, which govern the exterior world, it follows as a necessary consequence, that the peculiar constitution and relations of the inorganic elements of the crust of our globe, must affect the physical and mental endowments of man.

The solid portion of the globe has been constructed for man, just as the body has been made for the soul. The mutual relations of the solid and fluid portions of our globe, and the distribution of the forces of the sun, have exerted no small influence upon the physical and mental development of the human race.

The endless circulation of matter resulting from the combined actions of the forces of the sun, and the forces of the matter of our globe—every earthquake which, in past or present times, has fractured and dislocated the solid strata of the earth, elevated the bed of the ocean, or depressed the level of the continents—every volcano which has poured forth the liquid contents of the interior of the earth—every flood which has swept over the ancient continents—has contributed, more or less, to the formation of a suitable soil for the maintenance of plants and animals, and the development of the human race.

The examination of the mutual relations of celestial and terrestrial bodies, and animated beings, demonstrates that the existence of man is absolutely dependent upon the relations of the component members of the universe—that a single alteration in the chain of phenomena would destroy the conditions necessary for the existence and manifestation of the phenomena of man—that the forces of man are resultants of the forces of the sun and fixed stars, which keep up a never-ending circulation and change of matter upon the surface of our globe—that man cannot create or annihilate force, any more than he can create or annihilate matter—that the great law of the indestructibility of force, of action and reaction, applies to the phenomena of man, and consequently the intellectual and moral faculties are limited to the guidance and direction of the forces with which the Creator has endowed the universe—that man comprehends within himself all phenomena, astronomical, physical, chemical, physiological, and psychological, and is therefore a type of the universe—that the knowledge of the structure, phenomena and relations of man, includes a knowledge of science, whether relating to matter or mind.

The phenomena of man are complicated and restricted, and depend for their existence and manifestation, ultimately upon the general phenomena which affect all bodies; and if we wish thoroughly to undertand medical, (physiological, pathological and therapeutical) phenomena, we must analyze the component phenomena of man, and commence the study with the most general, unrestricted and simple phenomena, and then rise gradually to the knowledge of the more complicated and restricted phenomena, and finally attempt to gain an eminence of thought, from which we may survey the phenomena of man in their mutual relations, and in their relations with the exterior universe.

As the material part of man has been constructed with exact reference to the exterior universe, so the intellect of man has been constructed with exact reference to the exterior universe. The material part of man has also been constructed with exact reference to the structure of the intellectual and moral natures; it stands between the exterior world and the mind, and as a portion of the exterior world, a machine governed by the laws of exterior bodies, typical of the great mechanism of the surrounding universe, it forms a fit instrument for the manifestation of the Spirit breathed into it by the Creator of the Universe. The material body of man, with its complicated machinery, appears to have been constructed with exact reference to the action of the intellectual and moral nature. Thus, the complicated apparatus of the nervous system relates the mind of man, through the senses, with the exterior world; and the complicated muscular apparatus obeys the volitions of the mind through the nervous system, and accomplishes various mechanical actions, by which matter is moulded, and its forces controlled and directed according to the interior ideal creations of the intellectual faculties. The forces which work the muscular locomotive system, are developed by the chemical changes of the elements of the muscles and nutritive fluids. The office of the digestive and circulatory and respiratory systems, is to prepare materials which will readily enter into chemical change, and thus generate the forces by which under the guidance of the mind the locomotive apparatus of the body may be moved, and the barriers and obstacles in nature overcome, and the forces of matter controlled and directed, so as to accomplish definite effects.

In whatever manner the intellect of man be regarded, whether as an indivisible immaterial agent, or as a product or secretion of the brain, many metaphysicians have found it convenient, if not absolutely indispensable, to divide and classify its powers or faculties. Thus, for purposes of systematic study, analysis and comparison, metaphysicians have designated:

I. The Simple Cognitive Faculties, by which we attain the knowledge of individual objects in the concrete, as, (1.) Sense-Perception, by which we know material substances in certain modes, or in the exercise of certain qualities; and, (2.) Self-Consciousnese, by which we know self in certain states.

II. The Retentive and Reproductive Powers, as, (1.) Memory, which recalls what has been before the mind, with a belief that it has been before the mind in time past; (2.) Imagination, which puts what has been before the mind in new and non-existing forms. Both of them possess an Imaging, or Pictoral power. When this might fail, we have, (3.) the Symbolic power, which enables us to represent objects by signs.

Above the presentative and representative powers, we have;

III. The Correlative faculties, discovering such relations as that. (1.) of whole and parts; (2.) of sameness and difference, in respect of such qualities as space, time, quantity, and active property, and, (3.) of cause and effect.

IV. The Moral Faculty, determining in regard to certain mental states, that they are right or wrong.

Associated with the exercise of these powers, we have:

V. The Emotions, attaching us to certain objects, and withdrawing us from others.

VI. The Will, or Operative Power, choosing or rejecting among the objects presented to the mind.

It should be added that there are laws of association, determining the order of succession of the states produced by these various powers.

Science is the interpretation, by the mind, of the actualities of existence. The ideas of the mind are science or truth, only when they are correct expressions of the phenomena and laws of the universe. The end of science, and the proof of its truth, is the power which it confers upon man, of predicting future events.

For the discovery of truth and the establishment of science, we must have a mind endowed with special faculties, capable of analyzing and comparing its own phenomena, and of inferring their fixed relations or laws; capable of receiving impressions through the nervous system and organs of sense, from exterior bodies, and of decomposing, analyzing, classifying and determining the fixed relations or laws of the exterior universe. If the faculties of the mind be altered, whilst the surrounding machinery of the material body, and of the external universe remain unaltered, the discovery of the relations of the facts and phenomena of the external universe would be impossible. Thus the love of Truth, as Truth, and for no other reason, is a fundamental principle of the human mind, the knowledge of the existence of which is derived from consciousness; it is a primary principle, whose existence must be referred immediately to the Divine command. This is true of all the faculties of the mind; we can give no other reason for their existence and modes of action, than the will of the Creator. If the love of Truth was not a fixed disposition of the human mind, it would be impossible to receive any fact on testimony—it would be impossible to carry forward any investigation—it would be impossible to construct science. In like manner, if the structure and functions of the nervous apparatus, which relates the intellecual faculties with the exterior world be altered, whilst the intellectual faculties and the exterior world remain unaltered, the discovery of truth would be impossible.

It is evident, therefore, that imperfections of the senses, imperfections of the nervous apparatus, and peculiarities of mental endowments are the first sources of error in the prosecution of knowledge.

The mind has no direct communication with exterior bodies; its relations with the exterior world are through the nervous system, endowed with special sensibilities, and developed upon the exterior into the organs of sense. The organs of sense are nothing more than portions of the nervous system adapted by conformation, and the addition of peculiar apparatus, to receive and transmit impressions from exterior bodies. The mind can have no other knowledge of the exterior world, than that which is derived from the cognizance of the excited states, modifications or disturbances in the apparatus endowed with special sensibility, when acted on by the impressions of external bodies; and if all the organs of sense were absent, the mind would be shut up to itself, and would never acquire any knowledge of the various forms of matter, and of the various affections and motions of matter in the exterior world.

The phenomena, or associated facts of the exterior world are innumerable: matter is never at rest; it is constantly undergoing alterations of form, appearance and constitution—perpetual change is written everywhere; even the sun with his planets are sweeping majestically through space, around a distant, unknown centre; these changes of states, forms and conditions, and these modifications of relations, are the subjects of sensations and perceptions, and are represented to the mind as simple ideas. The causes of the incessant activity of the component members of this world and of the universe, cannot be discovered by the unaided senses; because the senses represent only the superficial exterior appearances and relations of bodies, and cannot penetrate beyond, and are therefore limited in their respective capacities to the reception of simple ideas, and can never give any information of the immutable laws which govern matter; the true nature, therefore, of exterior objects, the laws which regulate the phenomena of matter, and the relations between the component members of the universe, are problems which the reasoning powers of man, and not his senses, can solve.

After the observation of the facts and phenomena of the exterior world, the intellectual faculties, by their powers of analysis, synthesis, causation and judgment, separate each fact from dissimilar facts, and arrange the simple ideas into species, genera and orders; thus acquiring a knowledge of new phenomena and associations of facts inaccessible to the external senses. By decomposing phenomena into their component facts, by analysis and comparison of these facts, the intellectual faculties form abstract ideas, which sum up the principles and laws of associated facts. The perfection of every science will, therefore, depend upon the dilligence and care with which its cultivators study the simple properties and relations of bodies, and analyze, and decompose, and compare the more complicated phenomena. In the language of Bacon, "Man, as the minister and interpreter of nature, does and understands as much as his observations upon the order of nature permit him, and neither knows nor is capable of more."

The neglect of this, the only true method of acquiring a knowledge of the laws governing inorganic and organic bodies, has been the cause of the failures of the ancient systems of philosophy. Upon the imperfect knowledge of a few ill-observed facts and phenomena, the ancients reared immense superstructures, whose bases were points and their summits infinity.

The history of the origin and progress of human knowledge, at all times and in all places, demonstrates that in the pursuit of knowledge, and in the direct study of nature, facts alone do not constitute science, and reasoning alone does not constitute science. We must have for the construction of science, the exercise of the senses, furnishing the primary ideas, facts and phenomena of the exterior world; and then the exercise of the reasoning powers determining in virtue of their constitution, and relations through the senses to the exterior world, the fixed relations or laws of these facts and phenomena.

To the formation of science two things are requisite: Observation of things without, and an inward examination, decomposition, analysis and comparison of the results of observation.

It has been well said "that true knowledge is the interpretation of nature; and therefore it requires both the interpreting mind and nature for its subject; both the document and the ingenuity to read it aright. Thus invention, acuteness, and connection of thought are necessary, on the one hand, for the progress of philosophical knowledge; and on the other hand, the precise, and steady application of these faculties to facts well known and clearly perceived.

The great end, therefore, of all human knowledge and investigation is to determine the fixed relations or laws of the universe; so that the precise condition of things at any future time may be predicted with absolute certainty: and so that the human mind may appreciate its relations with the universe, and with the Creator of the universe.

It is evident from these principles, that education should commence with the exercise and discipline of the senses. The intellectual faculties should be taught, carefully to observe and note the properties and relations and forces of surrounding bodies, and to arrange and classify the phenomena.

In the first exercises of the senses and intellectual faculties, we should imitate, in a manner, the action of the human mind in the first dawn of science, when it first began to observe phenomena, and accumulate facts; and the method in which at the present time it originates and develops new sciences. Man commenced the construction of science, by viewing general classes of phenomena; the chronological commencement of science, therefore, is with a complex mass, whilst the logical development is with the individual elements. Thus, Astronomy, which is conversant with the sublimest and most striking phenomena in nature, had the earliest origin; its first cultivators were shepherds, who confined their attention to noting the most obvious phenomena of the motions and eclipses of the sun and moon, and the rising and setting of the stars. These, the first builders of Astronomy, slowly accumulated materials for the formation of science, and in due time the reasoning faculties compared the individual facts with each other, separated the dissimilar and combined the similar, and thus arrived at a knowledge of the fixed relations or laws which sum up and express the whole detail of associated facts.

It is evident from the mode in which the mind obtains its ideas and constructs science, that science is the result of patient and hard labor. The first knowledge acquired by the ancients consisted of isolated facts; gradually facts were accumulated, complex phenomena observed, decomposed, and their component elements arranged and compared, and the errors of the senses corrected, and it was not until after many ages that the great fundamental laws of Astronomy and physics were established.

We have thus endeavored in this physiological outline to sketch the general relations of man to the exterior universe, and to give a comprehensive demonstration of the extent and complexity of his phenomena; and we are thus led to conclude the subject with some general observations upon the *extent and imperfections of Pathological investigations*, thus connecting the preceding physiological studies with the succeeding pathological investigations.

If man be related to celestial and terrestrial bodies—if the existence of man be dependent upon the adjustments of the solar system, the seasons, the climate, the action of the vegetable kingdom, the soil, and upon the great circulation of matter, kept up by the forces of the sun—if the derangement of only one link in this complicated chain of phenomena would result in the destruction of the human race—if the phenomena of man in health be thus complicated, how much more complicated must be the phenomena of disease, when the constitution of the complex solids and fluids of man may be altered in many ways, and the relations between the physical, chemical, vital and nervous forces, and intellectual and moral faculties may be correspondingly deranged?

In view of the immensity and complexity of physiological and pathological phenomena; in view of the fact, that no single man, even during a long lifetime, is capable of investigating thoroughly the phenomena presented by disease, the investigator should state clearly his views of the extent and bearing of physiological and pathological phenomena, and define the scope and bounds, and methods of his investigations, and candidly acknowledge their omissions and imperfections.

We will now proceed, in a condensed and brief manner, to point out the sources of disease.

1. Astronomical changes are attended by corresponding changes in the phenomena of man. The changes of the day, and month, and year, and seasons are attended by corresponding changes in the constitution and phenomena of man. Not only would derangement of the adjustments of the solar system be attended by corresponding derangements in the little world of man, but his diseases, arising from whatever cause or causes, must be influenced by these changes. As the sun with his attendant planets are progressing continuously through space, it is not unreasonable to suppose that the phenomena of man might be modified by the properties and forces of the regions of space through which the solar system travels. That a resisting medium does exist in space, to which the transmission of luminous and thermic vibrations may be referred, has been conclusively demonstrated by astronomers in the case of Encke's comet. What the matter is composing this resisting medium, and whether this matter is uniform, or varies with the different regions of space, and whether it exerts any influence upon the phenomena of man, are questions worthy of solution.

Geology teaches that the climate of this earth has been altered during different periods of past time, and that causes have in past times destroyed whole races of plants and animals. Whether these causes were astronomical or terrestrial, it is nevertheless true that similar causes may be the sources of disease.

If the existence of man upon this globe be viewed in the light of the teachings of geology and astronomy, the conclusion appears to be reasonable that it will be limited to a definite period. The causes which may produce a final extinction of man, and of animals and of vegetables upon this globe, appear to have been and to be active in other worlds, and to require for their complete manifestation great periods of time. The changes, cosmic and astronomical which may result in the final destruction of the human race, will probably be so slow and almost imperceptible in their action, as to be detected only by the careful comparison of records covering vast periods of time. Such investigations, have not as yet found a place in medical science, and it may be possible that centuries may elapse, before the slow action of agencies which have been operative in the past history of this and other worlds, shall arrest the serious attention of those who are specially charged with the investigation of the nature and causes of disease.

2. The surrounding medium may be physically and chemically altered, either by an excess or deficiency of its ordinary ingredients, or by an excess or deficiency of the forces by which it is circulated.

Whilst it is true that the amount of force annually received by the earth from the sun is a fixed quantity, it is nevertheless true that, owing to the peculiar constitution of the atmosphere, the nice adjustment of its forces (the ease with which one mode of force may be converted into another, as heat into electricity, and *vice versa*), its relations to moisture, its relation to the distribution of the forces of the sun, and its relations to the distribution of the solid and fluid masses of the earth; and that climate is subject to variations which cannot be predicted, and are not uniform. Corresponding disturbances are produced in the phenomena of man. The truth of this proposition is conclusively demonstrated by the relations of certain diseases, as pleurisy and pneumonia, to the weather. And even when diseases are not directly produced by the disturbances of the structure and forces of the surrounding medium, it is nevertheless true that the course and phenomena of disease are modified, to a great extent, by meteorological phenomena. The value of the determination of these relations in the investigation of the origin, progress and treatment of disease, cannot be over estimated.

3. As the compounds composing the body of man have all been formed by the vegetable kingdom, from the inorganic elements, it follows that any deficiency of the necessary elements

f the soil would be attended by deficiencies in the constitution and composition of the ood, elaborated by the vegetable kingdom, and by corresponding disturbances of the constiution and phenomena of man. Corresponding changes in the constitution and phenomena f plants may be induced by meteorological phenomena. Hence, in the investigation of the rigin and phenomena of disease, it is necessary to determine the chemical and physical contitution of the soil, and its relations to the vegetable kingdom.

4. The salts of the blood, which are absolutely necessary to its healthy constitution, are btained in part from the water daily introduced into the system. These salts may exist in deficiency or excess; and other abnormal noxious, saline and organic matters may exist in the water. Each of these causes may be a source of disease. Hence the necessity in pathological investigations of a careful examination of the water.

5. Any one of the normal constituents of the body of man, may be deranged, and occupy different relations to each one of the other constituents. As these constituents are numerous, the resulting derangements may be correspondingly numerous. The forms of this class of disease may be as numerous as the different positions which the elements may be made to assume towards each other.

6. Any one of the elements of the body may be in excess or deficiency, and the diseases may be as numerous as the elements themselves, and at the same time, totally different from the diseases arising from an alteration in the relative position of the elements.

7. Foreign morbific agents may be introduced into the fluids and solids, which will excite abnormal changes in the solids and fluids. The generation of these morbific agents will depend, in great measure, upon the relations of climate and soil, and water and organic matter, and the forces of the sun. The number of diseases of this class will correspond to the number of distinct morbific agents.

Combinations of these morbific agents may produce still more numerous and complicated diseases.

8. As the matter composing the human body is fashioned into definite organs and tissues destined to accomplish definite results, and combined into apparatus, definitely related to each other, it is evident that the disturbance of the mutual relations of any one of these organs and tissues and apparatus must, to a greater or lesser extent, produce corresponding disturbances in the component members of the human organism.

9. The Creator has associated the vital force with a definite constitution of matter. Whatever interferes with this constitution, interferes with the action of the vital force. Whatever interferes with the vital force, necessarily disturbs its relations with the physical, chemical, and nervous forces. If the balance of the forces, and their correlation be disturbed, the chemical action between the elements may not only be deranged in kind, but also in degree, and the generation of the physical forces which work the machinery, and the manifestation of the nervous, intellectual and moral phenomena, correspondingly altered.

10. The development and structure of the vegetable kingdom—the development and structure and actions of the most simply constructed animals—the appearance of the nervous system in the animal kingdom, and in the fœtus of the higher animals, subsequently to the grouping of the atoms of formless matter into definite forms and apparatus—the formation of the digestive and circulatory apparatus, before the formation of nervous cells and nervous systems, demonstrate unequivocally, that development, nutrition, and the direction of the forces of matter to the fashioning of another part are under the guidance of the vital principle —demonstrate that the nervous system is itself developed and its perfection maintained under the guidance of the vital principle. Hence diseases may arise independently of the nervous system. Hence we may have chemical and physical changes of the elements of all the organs and systems of organs, incompatible with the existence of the vital force in that altered matter.

Whilst we admit these propositions, we must at the same time bear in mind the true offices of the nervous system. The nervous system is the last and best work of the forces of matter directed by the vital force, and is destined to form the medium of communication between the intellectual faculties and the exterior world; and is destined to connect together and influence the various organs and apparatus; and is destined to regulate secretion and excretion, and the consequent development of force; and is destined to excite and control the actions of the dynamic muscular apparatus, not by the possession and emission of a peculiar force generated *de novo*, but rather by a modification of physical force generated by the mutual chemical reactions of the blood and nervous system.

That the nervous force is not capable of itelf of carrying on the acts of nutrition, secretion and excretion, is demonstrated by the fact that plants, and the simply constructed animals, which are devoid of a nervous system, are capable of carrying on the offices of generation, development, digestion, assimilation, nutrition, secretion, excretion, and of preserving a definite form amidst unceasing chemical changes. Many of the simply organized animals, although without a nervous system, still possess sensation and voluntary motion. The nervous system appears only when the parts of the machinery are complicated. and need special means of communication.

The development and perfection of the nervous system correspond exactly to the development, perfection and complication of the organs and apparatus. This fact is true of the animal kingdom in its successive degrees of development, and also of the successive stages of the development of the solids and fluids of each individual highly organized animal. Physical and chemical actions take place in a similar manner in all animals, simple or complex; they differ only in intensity. The higher the animal, the more complicated its parts, the more rapid the chemical changes, and consequent generation of the forces, and the greater the necessity for some special apparatus which will bring all the complex organs and actions into harmonious relation.

Unless the actions of different organs can be telegraphed (so to speak) to each other, confusion in a complicated organism will necessarily result. Thus, if the amount of blood circulating through any organ and the chemical actions are too great, how can they be regulated without some medium of communication, and some means of regulating the chemical and physical actions?

The true relations of the nervous system to disease must be based not only upon the relations of the sympathetic system to the organs, and to circulation, respiration, secretion, excretion and nutrition; and of the cerebro-spinal system to motion and sensation; and of the sympathetic system to the cerebro-spinal system; but also upon the relations of the intellectual faculties to the nervous system, and through the nervous system to circulation, respiration, secretion, nutrition and excretion. If the views promulgated by Prochaska and Gall be true, that each faculty of the intellect is connected with a special portion of the brain, as the organic, material condition of the associated faculty, then aberration of those faculties would point to organic or functional alterations of the corresponding portions of the brain, just as an aberration or loss of sensation would point to the functional or structural alterations of the nervous apparatus devoted to the reception and transmission of sensational impressions; just as an aberration or cessation of respiration would point to a structural or functional alteration existing either in the nerves or in the apparatus of respiration. Whether the views of Prochaska and Gall, and of their followers, the phrenologists, be true or false, it would be nevertheless true that if the action of the intellect, when manifested by motions, or sensations, or consciousness, is always attended by chemical and physical changes of the nervous structures, then aberrated intellectual action would point to organic or functional changes in the nervous system. As in the case of aberrated motion and sensation, and of secretion and excretion, circulation and respiration, the cause of the aberration may lie entirely without the nervous system, in chemical and physical changes of the blood, induced by the catalytic action of morbific agents, so also, in the case of aberrated intellectual action it may arise from chemical and physical changes in the blood, arresting or altering the normal chemical changes of the organs of the intellect.

11. In investigations into the causes and effects of disease, the pathologist should remember that the origin of the disease may be connected with derangements in the constituents of the blood and of all the organs, independent altogether of the nervous system. Thus, in malarial fever, the poison, whatever it be, destroys the blood corpuscles, destroys the ferment in the blood, which converts the animal starch, elaborated in the liver, into grape sugar, and produces profound alterations in the structures, blood and secretions of the liver and spleen. Now, in the beginning, these effects may take place entirely independent of any alteration in the nervous system In this case the nervous system will be secondarily affected, and its action seriously disturbed, and this disturbance will give rise to a distinct set of phenomena; but it is evident that the cause and origin of this disease lies back of this disturbance.

The study of the physician does not cease with these phenomena.

12. Whilst in the physical universe and in the structures of animated beings the phenomena are connected by determinate, definite relations, in the moral world there is a disturbing element acting contrary to all harmony. The history of the world presents a mournful picture of a strife between two great antagonistic principles of good and evil. . Every individual that is born into this world forms a fresh battle-field for the conflict of these principles. In his present state, man resembles the ruins of a majestic temple; those columns, though marred and broken, still retain enough of beauty and symmetry to remind us of its former grandeur; the inscription upon the wall of the innermost chamber, although covered with the damp and decay of ages, still points to a hand Divine. The pleasant sentient emotions excited in the nervous system by benevolent actions and the strict adherence to truth, prove that the cultivation of the virtuous affections is favorable to health. While, on the other hand, the irritation, weakness, and morbid excitability of the nervous system produced by the indulgence of the evil passions, envy, jealousy and revenge—the haggard countenance, the withered, blasted form of vice—prove that the indulgence of the principle of moral evil injures and wastes the body; prove that the intellectual and moral faculties act upon the material body by which they are environed; prove that the material body may be rendered unfit

r the normal exercise of the moral and intellectual faculties ; prove that the knowledge of the ysician should extend not merely to the physical, chemical, physiological and pathological enomena of the body, but should embrace the structure of the intellectual and moral facul- es, and their relations to the material body by which they are environed.

It is evident, then, that the complete investigation of the origin, causes, effects and treat- ent ot disease demands an examination of the relations of man, during health and disease, astronomical phenomena ; demands an examination of the relations of man to the distri- ition of the terrestrial masses, to the soil, climate and waters, not only at the present time, it in the past history of the relations of man to astronomical and terrestrial phe- omena ; demands an examination of the structure and relations, and alterations of the solids d fluids of the organs and systems of organs, and tissues, and blood, and secretions, d excretions; demands an examination of the physical and chemical changes, and the lations of the physical, chemical, vital, and nervous forces: demands an examination of e relations of the physiological and pathological alterations of the nervous system to secre- on, excretion, sensation, motion, and intellectual and moral actions.

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INVESTIGATIONS

ON

THE NATURE, CAUSES, RELATIONS,

AND TREATMENT OF

TRAUMATIC TETANUS,

ILLUSTRATED BY

Observations on Various Diseases of the Nervous
System, and by Experiments on
Living Animals with
Certain Poisons.

INVESTIGATIONS, ON THE NATURE, CAUSES, RELATIONS AND TREATMENT OF TRAUMATIC TETANUS, ILLUSTRATED BY OBSERVATIONS ON VARIOUS DISEASES OF THE NERVOUS SYSTEM, AND BY EXPERIMENTS ON LIVING ANIMALS WITH CERTAIN POISONS.

CHAPTER II.

OBSERVATIONS ON THE NATURAL HISTORY OF TRAUMATIC TETANUS. CHANGES OF THE PULSE, RESPIRATION AND TEMPERATURE. CHARACTER AND CHANGES OF THE URINARY EXCRETION.

Observations on the Natural History of Traumatic Tetanus. Changes of the pulse, respiration and temperature. Characters and changes of the urinary excretion, qualitative and quantitative. Cases illustrating the Natural History of Traumatic Tetanus. The essential phenomena of fever and inflammation, absent in Traumatic Tetanus; the symptoms exaggerated manifestations of nervous and muscular actions, rather than of structural alteration; an irritation in a distant nervous branch is propagated to the spinal cord, and the disease after its establishment, appears to be dependent upon an undue excitability and increased action of the entire spinal ganglia, as manifested in the greatly exaggerated reflex actions. Reflexion of the increased activity of the ganglionic cells of the spinal cord, to the sympathetic nervous system.

Demonstration of increased chemical change in the muscular and nervous systems in Traumatic Tetanus. Historical notes upon the condition of the animal temperature in this disease. Observations of Hippocrates, Aretæus, Paulus Ægineta, Celsus, John Brown, William Cullen, Lionel Chalmers, Benjamin Rush, John Hunter, James Currie, Benjamin Travers, Robert Bently Todd and others, upon the Natural History and more especially upon the condition of the temperature in Traumatic Tetanus.

The sudden and rapid rise of the temperature in certain cases of Traumatic Tetanus near the fatal issue, referred to several causes, as 1st, the effects of the violent muscular contractions and agitations; 2d. Impeded respiration; 3d. The supervention of inflammation of some one or other of the internal organs, but more especially of the lungs as in pneumonia; 4th. The translation or extension of the irritation of the gray matter into true inflammation; 5th. The extension of the irritation from those portions of the spinal cord especially connected with the reflex functions to those ganglionic centres within the brain and spinal cord, which regulate the production of animal heat; 6th. The extension of the irritation to the sympathetic or vaso-motor system of nerves; 7th. Chemical and physical alterations of the blood. Portion of the nervous system involved in Traumatic Tetanus, intellect unaffected. Cases. Tetanus essentially consists in such a state of exalted functional activity in the nerve cells, as is attended with the constant generation of a larger supply of motor force, than is necessary for the maintenance of the normal relations between the nerves and muscles. Discussion of the mode in which the local irritation is conveyed by the nerves to the ganglionic cells of the spinal axis. Examination of the views of various anatomists and physiologists, as to the mode of termination and ultimate structure of nerves. Circulation and Respiration in Traumatic Tetanus. Intermittent action of the heart—observations upon spasm of the heart in this disease. Function of the skin activity performed; bowels constipated. Mutual relations of cerebro-spinal and sympathetic systems in this disease. Changes of the urine during the various stages of Traumatic Tetanus. Hypothesis as to the nature of the disease.

NATURAL HISTORY OF TRAUMATIC TETANUS.

In the first case of Traumatic Tetanus reported in this Chapter, the various phenomena were closely observed and noted, the urine carefully analyzed, the various phenomena examined and compared, and general results and conclusions deduced. The true nature and laws of disease can only be established by the Inductive Method. Each case properly examined and recorded, throughout its entire course, will afford data for the establishment of general principles; because under like circumstances, and in similar constitutions, each well marked case of disease, will present characteristics as fixed and as well marked, as the different species of animals and plants, and the laws by which it is governed, will be found to be as fixed and as characteristic as those which govern the healthy organism under the action of well known agents. Whilst holding the belief in the fixed characters and laws of disease, it is at the same time admitted, that observations should be extended to the farthermost possible limits, because diseases may present differences, as distinct as the varieties of the human constitution, and may be influenced in their manifestations, by modes of living and by climate: and in each case nature performs an experiment, as it were, the subjects of disease being placed in so many diverse conditions, by which the different morbid manifestations may be developed or modified; and in these various modifications and their manifest results, the student is frequently enabled to gain an insight into the working of hidden laws.

No disease presents more uniform, or more strongly marked characters than Traumatic Tetanus; and hence we can, with the more confidence, attempt to settle, general principles, from isolated cases.

Case No. 1: Illustrating the Natural History of Traumatic Tetanus.

Gillstrap, Confederate soldier: age 37; dark complexion; dark hair and eyes; height, five feet six inches; weight, 145 lbs; athletic and strong in health; muscles well developed; has been in the military service of the Confederate States six months; previous to this time his occupation was farming.

At the battle of Secessionville, on James' Island, South Carolina, June 16th, 1862, whilst standing in a small house, and in the act of taking a cartridge from the box, a minnie ball passed through a plank in the side of the house, three inches in thickness, and entering the lower part of the anterior fleshy portion of the right fore-arm, passing through the extensor and flexor muscles, between the ulna and radius, splintered both bones, without however, fracturing them across.

The wound suppurated freely and appeared to be doing well, until July 6th, when the suppuration sensibly diminished, and the patient complained of spasmodic twitchings, and painful sensations in the muscles of the wounded arm and corresponding side, and along the spine, especially between the shoulders, and in the region of the cervical and brachial plexus; stiffness and uneasiness about the muscles of the jaws, and a painful sense of tightness about the ensiform cartilage; torpor of the bowels, and "loss of rest at night." The spasmodic contractions and twitchings of the muscles of the wounded arm, were excited and increased by the slightest movements, and were especially aggravated by coughing. The act of coughing was not only attended with great pain, but also with spasmodic contractions of the muscles of the thorax and neck.

For several days previous, the bowels had been constipated, and in like manner with this characteristic symptom, the sense of oppression of breathing, restlessness, and loss of sleep, preceded the well marked symptoms of tetanus.

The expression of the countenance is that of distress, and even of pain, and the muscles of the face are greatly distorted during the paroxysms.

During the night and following day, (July 9th,) the pain in the arm and between the shoulders, and at the præcordium increased, and in like manner the stiffness of the jaws; the tetanic spasms became more violent and frequent; opisthotonos became more marked, and the disturbance of respiration was progressively increased during the paroxysms.

Administered in the morning, ten grains of calomel, which was followed with half a fluidounce of castor oil, in four hours. These purgatives failed to move the bowels. At bed-time, administered forty drops of tincture of opium, (Laudanum); and as this dose failed to produce sleep, thirty drops more were administered two hours afterwards. After the second dose the patient rested somewhat better; the spasms appeared to be slightly moderated, and the patient slept a little between the severe spasms.

July 8th, 12 o'clock, M. Patient says that he feels a little better; at the present moment the spasms do not appear to be so violent, Pulse 82, soft and full; respiration quiet and regular between the paroxysms, but disturbed and almost arrested during the spasms.

Temperature of hand, 37°.6 C. (99°.7 F.): of axilla, 37°.9 C. (100°.3 F.)

Examination of Urine—High colored and scanty: amount excreted during sixteen hours, (from July 7th, 8 o'clock, P. M., to July 8th, 12 M.,) 4823 grains (Troy); if from this data, the amount of urine be calculated for twenty-four hours, it would be equal to 7234.32 grains. Specific gravity, 1021.55. Reaction, strongly acid; Color deep orange inclining to red. Urine clear when first passed. After standing about 72 hours, a deposit fell, consisting chiefly of the phosphates; a dense yellowish white layer, also rose and completely coated the surface of the urine, to the depth of an eighth of an inch; this was composed of the phosphates of lime, magnesia and ammonia, amorphous granules, stellate and prysmatic crystals and vegetable cells. I have seen a similar thick scum, rise on the urine of typhoid fever after standing for some time; but never upon the urine of malarial fever.

The composition of the urine is given in the following table:—

No. 1.—*Analysis of Urine passed during* 16 *hours, from July 7th,* 8 *A. M. to July 8th,* 12 *M. Amounts expressed in Troy Grains.*

		Urine passed during 16 h'rs, July 7th, 8 A. M. to July 8th 12 M.	Amount and composition of Urine calculated for 24 h's	Average amount and composition of Urine passed each hour.
		GRAINS.	GRAINS.	GRAINS.
Amount of Urine		4823.00	7234.32	301.43
Water		4544.20	6816.24	284.01
Solids		278.74	418.08	17.42
Urea		145.60	218.40	9.10
Uric Acid		3.73	5.52	0.23
Free Acid		9.26	13.68	0.57
Phosphoric Acid		10.89	16.32	0.68
Sulphuric Acid		7.01	11.28	0.47
Chlorine		21.13	31.68	1.32
Equivalent Chloride of Sodium		34.67	51.84	2.16
Fixed Saline Constitu'ts	Entire Saline Constituents	67.49	101.04	4.21
	Phospates of Lime and Magnesia	8.76	12.90	0.54
	Sulphates, Chlorides and Phosphates of Alkalies	58.73	88.08	3.67

Upon consultation with Surgeon L. D. Ford, it was determined, to administer internally, sulphate of quinia, and a mixture of equal parts by measure of chloroform, sulphuric ether and tincture of opium.

R. Quiniæ Sulph: Grains XX; divide into four powders, and administer one powder at 12 M., 2 P. M., 4 P. M., and 6 P. M.

R. Chloroformi.
Ætheris Sulph:
Tinct. Opii: of each equal parts: mix: administer 10 drops every hour in sweetened water.

Nine o'clock, P. M. Pulse 88: bowels still unmoved: has taken twenty grains of quinine, and does not complain of any unpleasant effects in the head from this. The chloroform mixture has been administered continuously each hour, and the patient thinks that it has had the effect of somewhat diminishing the pain. and the severity of the spasms. I administered forty drops of Laudanum, and ordered this dose to be repeated in two hours; and the chloroform mixture to be continued, ten drops every hour.

July 9th, 12 M. Continues much the same; pulse 74; skin in a profuse prespiration. Surface feels cool. Tongue coated with white fur. The chloroform mixture appears to have slightly diminished the intensity of the spasms; they are however, very severe and frequent, and the suffering of the patient is very great.

Temperature of hand, 37.°55 C, (99.°6 F.); of axilla, 37.°85 C. (100.°2 F). Continue chloroform mixture:—Diet, chicken and beef soup, corn gruel and milk punch. The nourishment and the medicine are taken with great difficulty, and it is only when there is an intermission of the paroxysms, that the patient is able to suck them carefully through a quill.

Examination of the Urine—Dark brownish red color; Sp. G. 1023; reaction strongly acid; the microscopical examination yielded similar results to those previously recorded: In like manner, the thick scum formed upon the urine after standing.

No 2.—*Analysis of Urine passed during* 24 *hours, from July 8th*, 12 *M. to July 9th*, 12 *M. Amounts expressed in Troy Grains.*

		Urine passed during 24 hours. July 8th, 12 M. to July 9th 12 M.	Average Amount and composition of Urine passed each hour.
		GRAINS.	GRAINS.
Amount of Urine		10444.83	435.20
Water		9852.65	410.53
Solids		592.18	24.67
Urea		381.35	15.88
Uric Acid		4.09	0.17
Free Acid		27.61	1.15
Phosphoric Acid		39.96	1.66
Sulphuric Acid		21.24	0.88
Chlorine		45.22	1.88
Equivalent Chloride of Sodium		73.84	3.07
Fixed Saline Constituents	Entire Saline Constituents	148.94	6.20
	Phosphates of Lime and Magnesia	13.29	0.55
	Sulphates, Chlorides and Phosphates of Alkalies	135.65	5.65

Nine o'clock P. M. No improvement of symptoms. Continue Chloroform Mixture, twelve drops every hour; administer at once ten grains of Blue Mass (Pill Hydrargyri). and follow in four hours with one fluidounce of Castor Oil; and in the morning administer five grains of Quinine at 5 A. M., 8 A. M. and 11 A. M.

July 10th, 12 M. Tetanic spasms have increased in frequency and violence; bowels obstinately constipated; the Blue Mass and Castor Oil have had no effect. Fifteen grains of Quinine have been taken this morning without any apparent effect. Pulse 80; Temperature of Hand 37°.6 C. (99° 7 F.) of Axilla 38° C. (100°.4 F.)

Examination of Urine.—Brownish red color. Sp. Gr. 1025.25. Strong acid reaction.

No. 3.—*Analysis of Urine passed during* 24 *hours, from July 9th*, 12 *M. to July 10th*, 12 *M.*

	Urine passed during 24 hours, July 9th, 12 M. to July 10th, 12 M.	Average Amount and Composition of Urine passed each hour.
	GRAINS.	GRAINS.
Amount of Urine	11,625.76	901.07
Water	10,962.17	873.43
Solids	663.59	27.64
Urea	466.56	19.44
Uric Acid	11.45	0.47
Free Acid	33.88	1.38
Phosphoric Acid	45.76	1.90
Phosphates of Lime and Magnesia	16.00	0.66

Nine o'clock P. M. No improvement. Administered an enema of: molasses, one fluidounce, Common Salt one ounce, and water one pint; this in like manner with the purgatives failed to produce any action on the bowels. After the trial with the enema administered thirty drops of Laudanum, and ordered this dose to be repeated in two hours. Continue the Chloroform Mixture; and in the morning administer, five grains of Quinine, at 5 A. M., 7 A. M., and 11 A. M.

July 11th, 12 M. Continues to grow worse; bowels still without any movement; has taken fifteen grains of Quinine this morning. Pulse 84; Respiration 15; Temperature of Hand 37° 6 C., (99° 7 F.,) of Axilla 38° C. (100° 4 F.)

Continue Chloroform Mixture.

Examination of Urine.—Light red color; after standing 48 hours, notwithstanding the heat of the weather the reaction was still strongly acid; no deposit fell during this time; after standing a still longer time, however, a deposit of the phosphates was thrown down, and the thick scum rose upon the surface.

The urine emitted a distinct smell of Chloroform. Sp. Gr 1024.75.

No. 4.—*Analysis of Urine passed during* 24 *hours, July* 10*th*, 12 *M. to July* 11*th*, 12 *M.*

	Urine passed during 24 hours, July 10th, 12 M. to July 11th, 12 M.	Average Amount and Composition of Urine passed during each hour.
	GRAINS.	GRAINS.
int of Urine	6,457.50	269.06
	302.62	12.60
Acid	5.40	0.22
Acid	21.60	0.90
horic Acid	16.94	0.70
uric Acid	15.56	0.64
ine	10.59	0.42
alent of Chloride of Sodium	17.37	0.72
hate of Lime and Magnesia	10.39	0.42

e o'clock P. M. The tetanic spasms have greatly increased in violence and frequency
2 P. M. Patient emits a shrill, piercing cry, during the spasms, and the head and neck
awn back and downwards towards the heels, whilst the lower extremities are drawn in
anner backwards and upwards towards the head, with great violence. The patient
t lie down even in the intermissions, and is compelled to sit up upon the edge of the
is lower extremities being forcibly bent backwards under the bed. Two strong soldiers,
as nurses, are required to support the patient during the intermissions, and to hold
irmly during the spasms; for, without their assistance, the patient would be thrown
tly against the wall, by the powerful contractions of the muscles of the neck and back,
ing the head backwards towards the heels. At one time, when the spasms came on
tly, the patient was projected with force over the bed, and his head struck the wall
a heavy and painful blow.

e jaws are very rigid; it is impossible, even during the most complete remissions, to
ude the tongue; and it is only by the greatest care, and by a careful selection of the
complete remissions, that he is able to take the Chloroform Mixture and a little nour-
ent.

e spasms are excited by sounds, by currents of air, or by a sudden touch. The mus-
f the face are contorted, and the angles of the mouth drawn up; the nostrils are ex-
d; the eyes fixed and drawn inwards, the forehead is deeply wrinkled, and the whole
enance is expressive of great anxiety, distress and suffering; complains of great pain,
drawing" in the muscles between the shoulders, in the neck and in the region of the
ragm.

wound in the arm looks dry and is of a bluish and purplish red color, and has ceased
charge pus;—the discharge now consists of a small quantity of serous fluid.

cture of Iodine was poured into the wound; the fore-arm was also painted with it.
pplication of Tincture of Iodine directly to the wound appeared to increase the spasms.
diately after, the patient had several terrible spasms, during which he emitted sharp and
ng cries.

*pulse was intermittent during these violent spasms, but became regular again after a short time,
they had passed off. The intermission in the action of the heart did not take place until the estab-
nt of the spasm, and continued for some time after the intermission of the spasm, the disturbance
action of the heart was therefore evidently caused by the spasm.*

passed no urine since 12 M., and says he is unable to do so.

dministered thirty drops of Laudanum, together with thirty drops of the mixture of Chlo-
n, Ether and Laudanum, and directed this dose to be repeated in two hours, together
the hourly administration of fifteen drops of the Chloroform Mixture, and in the morn-
re grains of Quinine at 5 A. M. 7 A. M., and 9 A. M.

y 12th, 12 M. Spasms not so violent as yesterday; appears to have been benefitted by the
se in the Chloroform mixture. Pulse, respiration and temperature continue much the
Pulse 84 per minute; intermittent during the spasms. Has taken fifteen grains of
ne this morning. Thus far I have observed no beneficial effects whatever from the
ne; on several occasions it has appeared to aggravate the spasms; whilst, on the other
improvement always appeared to follow the free use of the Chloroform Mixture. Ad-
tered thirty drops of Laudanum and thirty drops of Chloroform Mixture, and repeated
ose half an hour after, and ordered the continuance of fifteen drops of the mixture each

mination of Urine.—Deep red color. Sp. Gr. 1024.5. Strong acid reaction. During
y-four hours, from July 11th, 12 M., to July 12th, 12 M., has passed only 4026 grains of

The patient affirms, and his statement is confirmed by the nurse, that this is the entire amount passed during this period. During the severe spasms, it was impossible to void the urine, and the difficulty is still great. After standing, a thick scum rose upon the surface.

No. 5.—*Analysis of Urine passed during 24 hours, July 11th, 12 M. to July 12th, 12 M.*

	Urine passed during 24 hours, July 12th. 12 M. to July 12th. 12 M.	Average Amount and Composition of Urine passed each hour.
	GRAINS.	GRAINS.
Amount of Urine	4,026.28	167.77
Urea	177.50	7.39
Uric Acid	3.26	0.13
Free Acid	15.37	0.64
Phosphoric Acid	12.87	0.53
Sulphuric Acid	9.57	0.37
Phosphates of Lime and Magnesia	5.03	0.20

Nine o'clock P. M. There appears to be a slight improvement of the symptoms.

Pulse 88. Has passed no urine this day. Bowels obstinately coustipated. Painted the wounded arm with Tincture of Iodine, and poured the Tincture into the wound: this caused some pain, and an increase of the spasms; administered forty drops of Laudanum, with thirty drops of the Chloroform Mixture, and ordered this dose to be repeated in two hours, and also the continuance of the Mixture, fifteen drops each hour.

July 13th, 11 A. M. Appears somewhat more quiet. The second dose of Laudanum and Chloroform Mixture, administered last night, induced some rest, and the patient slept two hours. The Tetanic spasms appear to have lessened a little in severity, and the wound is commencing to suppurate. Administered thirty drops of Laudanum and thirty drops of Chloroform Mixture, and ordered the Chloroform Mixture continued in the usual dose, also five grains of Quinine at 12 M., 2 P. M., and 4 P. M.

Nine o'clock P. M. Has passed more urine than usual this day.

The symptoms have changed for the worse—the paroxysms are more violent, and the suffering more acute—the patient cries out in each spasm. Position, sitting upon the edge of the bed, held by two strong soldiers, as previously described; the action of the muscles also, in drawing the head towards the heels, is similar, and fully as powerful. Pulse 90 in the sitting posture.

During the spasms, and for some time after, the pulse beats irregularly. One powerful impulse, followed by two feeble impulses, and then a complete cessation of action; no impulse whatever.

When the spasms are delayed, the heart gradually returns, between the paroxysms, to its normal regular action and the pulse resumes its regular beat.

I carefully examined the relations of the perturbations in the heart's action to the Tetanic spasms, and found that they *succeeded*, but never preceded the spasms; thus indicating that, either an influence was transmitted from the medulla oblongata, through the Pneumogastric nerves to the ganglia and nerves of the heart, causing spasms in the muscular fibres similar to those excited in the muscles under the control of the volition, by the peculiar state and force of the spinal axis and motor nerves; or else the sudden contraction of the muscles and the suspension of respiration, not only suddenly forced much blood upon the heart, but also forced blood improperly oxygenated, and abounding with Carbonic Acid, upon the heart, and thus deranged its actions by distending the cavities with venous blood.

The first supposition appears to be the most reasonable, because the phenomena were too regular, and the irregularity of the heart's action lasted too long after the disappearance of the spasms, and gradually disappeared after the entire cessation of the spasm: and farther, because muscular exertion, and the presence of venous blood accelerates, rather than retards the action of the heart. A fact stated by physiologists, that on stimulating the cervical trunk of the Pneumogastric nerves, with an electro-magnetic current, the action of the heart is generally arrested, while, when the experiment is successfully repeated on the trunk or branches of the sympathetic, its pulsation is always accelerated, would strongly support this view.

Twenty-five drops of Laudanum, with an equal number of the Chloroform Mixture, were administered, and as they appeared not to afford any special relief, the dose was repeated at the end of half an hour. The continuance of the Chloroform Mixture, as usual, together with five grains of Quinine at 5 A. M., 7 A. M., and 9 A. M., were ordered.

July 14th, 11 A. M. The patient did not rest during the night—it was impossible for him to recline, even for a few moments, although a most comfortable chair was fixed, which afforded the opportunity of resting in the sitting posture. The chair could not be used as account of the great contraction of the muscles of the back, neck and legs. The patient was compelled to sit upon the edge of the bed all night, as in the preceding nights, supported by two strong soldiers. Pulse 98, in sitting posture. Respiration natural between the paroxysms. Surface of the skin, as usual, bathed in perspiration. Temperature of Hand 38° C. (100°. 4 F). It was difficult to determine the temperature of the axilla, on account of the violence of the spasms; it appeared, however, to preserve the same relations to that of the hand previously noted, being a little less than one degree Fahrenheit above the latter.

During the intermissions, when the spasms are delayed for some time, the pulse was regular; during the commencement of the spasms, the pulse became fuller and more rapid for the first few moments, and then it became irregular—one full impulse, then two lesser impulses, and then a cessation of one beat. Has taken fifteen grains of Quinine this morning.

R. Magnesiæ Sulphatis one ounce; Aquæ Distillatæ, six fluidounces; make a solution, and administer at once.

R. Chloroformi, one fluidounce; Pulv: Camphoræ one ounce; Tincturæ Opii, one fluidounce; Olei Olivæ, four fluidounces; dissolve the Camphor in the Chloroform, and then mix with the Sweet Oil and Laudanum. Use this as a liniment to the muscles of the neck and back.

Continue the application of Tincture of Iodine to the wound, and also rub the entire arm with Iodine Ointment.

After applying the Tincture of Iodine to the wound, introduce a small quantity of the Iodine Ointment into the wound. I hoped by these measures to excite suppuration in the wound, and also to produce counter-irritation over the region of the nerves connected with the injured textures.

Examination of Urine.—More abundant, and not so highly colored, being a deep reddish orange. Strong acid reaction. Specific gravity, 1022.

After standing, the urine presented the same characteristics as those previously noted.

No. 6.—*Analysis of Urine passed during* 48 *hours, July* 12*th*. 12 *M. to July* 14*th*, 12 *M.*

		Urine passed during 48 hours, July 12th, 12 M. to July 14th, 12 M.	Average Amount and Composition of Urine passed each 24 hours.	Average Amount and Composition of Urine passed each hour.
		GRAINS.	GRAINS.	GRAINS.
Amount of Urine		24,139.64	12,069.82	502.90
Water		22,651.58	11,325.79	471.96
Solids		1,488.06	744.03	30.00
Urea		1,042.20	521.10	21.71
Uric Acid		13.46	6.73	0.28
Free Acid		98.43	49.21	2.05
Phophoric Acid		78.02	39.01	1.62
Sulphuric Acid		67.47	33.73	1.40
Chlorine		77.66	38.83	1.61
Equivalent Chloride of Sodium		127.41	63.70	2.65
Fixed Saline Constituents	Entire Saline Constituents	188.96	94.48	3.93
	Phosphates of Lime and Magnesia	33.06	16.53	0 68
	Sulphates, Phosphates and Chlorides of Alkalies.	155.90	77.95	3.24

Nine o'clock P. M. Through mistake, the nurse failed to administer the Chloroform Mixture, and the patient has suffered greatly during the day. The Epsom Salts (Sulphate of Magnesia) failed to exert any effect upon the bowels.

The Chloroform liniment afforded some slight relief to the pain between the shoulders; at present, however, the spasms are not so severe as they were this morning. I have again carefully examined the phenomenon of the action of the heart during the spasms. The effects of these lighter spasms, are not so marked as those of the severer spasms—they do not when light, cause the intermittent action of the heart, although they produce a certain amount of disturbance in its action.

Administer at once, forty drops of Laudanum and twenty drops each of Chloroform and Sulphuric Ether, with one ounce of Sulphate of Magnesia, dissolved in six ounces of water.

Continue chloroform mixture and liniment.

July 15th, 12 M. More comfortable; spasms not so violent: they appear to be diminishing both in frequency and force. Pulse, 84, regular. Respirations in the remissions regular. Temperature of the extremities and trunk quite uniform, and about the same as last recorded. Says that he obtained some rest at 12 M. last night.

Administered 30 drops of Laudanum, and the same number of Chlorform Mixture, and ordered the mixture continued as before.

Examination of Urine.—Deep red color; Sp. Gr. 1026. The urine upon standing several days, presented similar phenomena to those previously recorded.

No. 7.—*Analysis of Urine passed during* 24 *hours, July* 14*th*, 12 *M. to July* 15*th*, 12 *M.*

	Amount and Constituents of Urine passed during 24 hours. GRAINS.	Average amount of Constituents of Urine passed each hour. GRAINS.
Amount of Urine	8,074.62	336.44
Water	7,585.46	316.06
Solids	489.16	20.38
Urea	386.00	16.08
Uric Acid	8.81	0.36
Free Acid	40.40	1.68
Phosphoric Acid	37.85	1.59
Sulphuric Acid	38,34	1.59
Chlorine	16.53	0.68
Equivalent Chloride of Sodium	27.13	1.12
Fixed Saline Constituents (Entire)	88.14	3.66
Phosphates of Lime and Magnesia	14.93	0.62
Phosphates, Sulphates and Chlorides of Alkalies	73.21	3.05

July 16th, 10 o'clock, A. M. Patient appears to be much better; spasms much less severe; jaws are much more relaxed, and the patient is able to talk with more ease. Pulse 86; Respiration 18; Temperature of Hand 37°.8 C. (100°.1 F.) of axilla 38°. C. (100°.4 F).

Continue the Chloroform Mixture and paint the arm with the Tincture of Iodine.

Examination of Urine.—Light red color; Sp. Gr. 1025.10. In twelve hours a deposit of Triple Phosphate fell; this is the first deposit thrown down in so short a period; heretofore, a heavy scum formed upon the surface of the urine, previous to the formation of a deposit, and in fact, itself afterwards became a large portion of the deposit, in consequence of portions sinking down after remaining on the surface for several days.

No 8.—*Analysis of Urine passed during* 24 *hours, July* 15*th*, 12 *M. to July* 16*th*, 12 *M.*

		Amount and Constitution of Urine passed during 24 h's, July 15th, 12 M. to July 16th, 12 M. GRAINS.	Average Amount and Composition of Urine passed each hour. GRAINS.
Amount of Urine		9,840.96	410.04
Urea		546.26	22.76
Uric Acid		7.48	0.31
Free Acid		23.62	0.98
Phosphoric Acid		16.37	0.68
Sulphuric Acid		77.67	3.23
Fixed Saline Constituents	Entire Saline Constituents	57.60	2.40
	Phosphates of Lime and Magnesia	29.18	1.21
	Sulphates, Phosphates and Chlorides of Alkalies	28.41	1.18

Nine o'clock, P. M. Pulse 100 in sitting posture, and intermittent after the severe spasms. Twenty-five drops of Laudanum, and an equal quantity of the Chloroform Mixture, with one ounce of French Brandy, diluted, were administered with good effect; and this combination repeated in half an hour, resulted in the "*first night's rest*," since the onset of the disease. Ordered an Enema of Salt and Molasses at once, to be repeated if necessary in the morning.

July 17th, 10 A. M. Continues to improve, rested much better during the night than at any previous time. The spasms continue to diminish in frequency and force. Pulse in sitting posture 82, full, soft and good. Tongue coated with light white fur. Temperature of Hand 37°.95 C. (100°.3 F.) Temperature of Axilla 38° C. (100°.4 F).

Continue Chloroform Mixture.

Examination of Urine.—Only 4,029 grains of urine have been collected during the last twenty-four hours. The patient affirms that this is the whole amount passed; he is a most reliable man, and I have every reason to believe that this is the amount, as both he and his nurses have taken the greatest interest in the examination of the symptoms, and especially of the changes in the urine, and have manifested every anxiety to aid me in all my inquiries. Four injections of salt and molasses were administered during the night, which failed entirely

luce any effect upon the bowels; during the action of these the patient may possibly
ıst some urine, he insists, however, that none was lost at any time.
r of Urine much lighter; deep orange.
tion of Urine not so acid.
ific Gravity, 1025.3.
following is the Composition of the Urine passed during twenty-four hours.

o. 9.—*Analysis of Urine passed during* 24 *hours, July* 16*th*, 12 *M. to July* 17*th*, 12 *M.*

	Amount and Composition of Urine passed during 24 hours. GRAINS.	Average Amount and Constitution of Urine passed each hour. GRAINS.
ıt of Urine	4,029.42	167.64
	183.36	7.64
cid	6.29	0.26
cid	8.10	0.33
ıoric Acid	5.67	0.23
ıric Acid	22.57	2.98
ıe	5.25	0.21
ılent Chloride of Sodium	8.63	0.36
ıates of Lime and Magnesia	8.64	0.36

o'clock P. M. Suffering somewhat more severely this evening. Ordered Brandy two
ınces, Laudanum one fluiddrachm, Chloroform thirty minims, sweetened water, six
ınces; mix, and divide into two parts; one to be taken immediately, and the other at
d of one hour. Continue the Chloroform Mixture, as before.
e 90 in the sitting posture.
18th, 11 o'clock A. M. Much better; says that he feels "like a new man;" rested well
the night; the expression of his countenance has greatly improved.
e 86; Respiration 14; temperature as in previous observations. Twenty drops of
num, with a similar number of Chloroform, were administered; and this dose was repeated
end of one hour. Continue Chloroform Mixture.
ination of Urine.—Amount of Urine passed during twenty-four hours, July 17th, 12 M.
y 18th, 12 M., 7722 grains. Sp. Gr. 1021.55. The color of the urine is less marked;
hich was passed yesterday, being of a light red color, whilst the color of the urine of
ıy is light orange and almost normal.

No. 10.—*Analysis of Urine passed during* 24 *hours, July* 17*th*, 12 *M. to July* 18*th*, 12 *M.*

	Amount and Composition of Urine passed during 24 hours. GRAINS.	Average Amount and Constitution of Urine passed each hour. GRAINS.
nt of Urine	7,722.54	321.77
	314.97	13.12
ıcid	7.56	0.31
ıcid	18.89	0.78
horic Acid	12.64	0.52
uric Acid	45.39	1.89
ne	23.17	0.96
alent of Chloride of Sodium	38.02	1.58
Entire Saline Constituents	36.28	0.77
Phosphates of Lime and Magnesia	17.69	0.73
ituents Phosph'tes, Sulph'tes and Chlorides of Alkalies	18.59	1.51

e o'clock P. M. Is now asleep; appears to be improving. Pulse 80. When the patient
ıs, administer twenty-five minims each of Chloroform and Tincture of Opium, with three
unces of Brandy.
r 19th, 11 A. M. Continues to improve, has had only three spasms this morning.
se 72. The patient had a light spasm, whilst I was counting his pulse; this did not
ıer affect the pulse and the action of the heart, as in the previous severe spasms.
ination of Urine.—Deep orange color; Sp. Gr. 1016.5. Urine more copious, the
ıt passed during the last twenty-four hours, being 10,876.55 Grains.

No. 11.—*Analysis of Urine passed during 24 hours, July 18th, 12 M. to July 19th 12 M.*

	Amount and Composition of Urine passed during 24 hours.	Average amount and Composition of Urine passed each hour.
	GRAINS.	GRAINS.
Amount of Urine	10,876.55	453.19
Urea	388.47	16.19
Uric Acid	8.56	0.35
Free Acid	30.44	1.26
Phosphoric Acid	20.59	0.85
Sulphuric Acid	30.32	1.26
Chlorine	37.82	1.57
Equivalent Chloride of Sodium	62.05	2.58
Phosphates of Lime and Magnesia	21.40	0.89

Nine o'clock P. M. Pulse 76: sleeping quietly: the examination of the pulse excited two slight spasms, which did not affect the rythm of the pulse.

July 20th. Much better: sitting up. Pulse 88.

Continue Chloroform Mixture.

R. Olei Ricini, one fluidounce.

July 21st, 1 o'clock P. M. Continues to improve: the oil acted once during the night; another fluidounce of Castor Oil was administered this morning, and was followed by an Enema, composed of one fluidounce of Molasses, half an ounce of common Salt, twenty drops of oil of Turpentine, and one pint of water.

These measures produced a large evacuation from the bowels, which as in the previous action, contained hard balls of fœcal matter.

Pulse 80: Respiration 16: Temperature of Hand 38°.5 C. (101°.3 F.) Temperature of Axilla 38°.6 C. (101°.5 F.)

At the present time, the patient does not appear quite so comfortable; had several spasms during the determination of the temperature. Tongue slightly coated with yellow fur. Administered thirty minims of the Chloroform Mixture, together with one fluidounce of Brandy, properly diluted with water, and ordered the Chloroform Mixture to be continued each hour.

The patient has continued steadily to improve, taking regularly the Chloroform Mixture, and Brandy, and occasionally Castor Oil, when indicated: which latter purgative, assisted by Enemas of Molasses, Salt and Water, have happily produced on this day, (July 21st), the first free evacuations from the bowels, since the sixth of July.

Examination of Urine.—Light orange color. Sp. Gr. 1010.

No. 12.—*Analysis of Urine passed during 48 hours, July 19th, 12 M. to July 21st, 12 M.*

		Amount and Composition of Urine passed during 48 hours.	Average Composition of Urine each 24 hours	Average Composition of Urine each hour.
		GRAINS.	GRAINS.	GRAINS.
Amount of Urine		21,018.40	10,509.20	437.88
Urea		489.03	244.51	10.18
Uric Acid		17.26	8.63	0.35
Free Acid		50.95	25.47	1.06
Phosphoric Acid		41.57	20.78	0.86
Sulphuric Acid		27.81	13.90	0.57
Chlorine		84.85	42.42	1.76
Equivalent Chloride of Sodium		139.20	69.60	2.90
Fixed Saline Constitu'ts	Entire Saline Constituents	117.52	58.76	2.44
	Phosphates of Lime and Magnesia	9.36	4.68	0.19
	Phosp'es, Sulp'es and Chlorides of Alkalies	108.16	54.08	2.30

Nine o'clock P. M. Much better. Wound discharging pus, which presents a thick, healthy appearance.

July 22d, 9 P. M. Pulse 80; has had a few light spasms, but, upon the whole, has been quite comfortable. The muscles of the jaw have gradually relaxed as the other symptoms improved, and he can now open his mouth with considerable ease. Had one action on the bowels after the administration of the Enema. Administered thirty drops of Laudanum and Chloroform, with one fluidounce of Brandy; and ordered an Enema of Salt and Molasses in the morning.

July 23d, 12 M. Much better; has had no general spasms, only slight twitchings of the arm: rested well during the night Pulse 80. Repeat Enema of Salt and Molasses, and continue chloroform mixture.

Examination of Urine.—Dark Red Color, Sp. Gr., 1015.

No. 13.—*Analysis of Urine passed during* 48 *hours, July* 21*st*, 12 *M. to July* 23*d*, 12 *M.*

		Amount and Constitution of Urine passed during 48 hours.	Average Am't and Constit'tion of Urine each 24 hours.	Average Am't and Constitution of Urine passed each hour.
		GRAINS.	GRAINS.	GRAINS.
Amount of Urine		31,160.50	15,580.25	649.17
Urea		617.21	303.60	12.65
Uric Acid		30.70	15.35	0.64
Phosphoric Acid		42.51	21.25	0.88
Sulphuric Acid		31.54	15.77	0.65
Chlorine		137.40	68.70	2.86
Equivalent Chloride of Sodium		225.41	112.75	4.69
Fixed Saline Constitu'ts	Entire Saline Constituents	232.92	116.46	4.85
	Phosphates of Lime and Magnesia	34.02	17.01	0.70
	Phosph'es, Sulph'es and Chlorides of Alkalies	198.90	99.45	4.14

The increase in the constituents of the urine, was no doubt due in great measure, to the increased amounts of food and fluids consumed. During the active stages of the disease, but little solid or fluid nourishment could be taken, hence all the constituents of the urine were diminished, and this excretion in the present case, was produced under a state approaching starvation.

The physical conditions induced by the peculiar nervous and muscular derangements, independent of any lesions of the internal organs, exerted powerful effects upon the character of the chemical changes in the blood and tissues, and corresponding effects upon the amounts and characters of the constituents of the urine.

To understand the signification of the changes of the urine in this case, they must be compared with the changes of this excretion under different states of rest and exercise, under various kinds of food, and especially during starvation.

Nine o'clock P. M. Patient says that he does not feel as well as he did this morning; pulse 90, full and strong; surface feels a little warmer than usual.

The enema this morning induced an evacuation of hard balls.

Ordered ten grains of Dover's Powder, (Pulv: Ipecac, et Opii), to be administered at once, and repeated in two hours, if rest is not induced.

Continue Brandy and Chloroform Mixture, and repeat the Molasses and Salt Enema in the morning.

July 24th. Says that he feels better, rested well during the night, having taken twenty grains of Dover's Powder.

The Enema has been retained, and has not yet acted; says that he feels an inclination to evacuate the bowels.

Pulse 76; Temperature of Hand, 37°.6 C. (99°.8 F.); of axilla, 38°.4 C. (101°.2 F).

This morning, for the first time during his illness, the patient has complained of "feeling *hungry*."

Examined the wound carefully with a probe, and extracted from the orifice, upon the internal surface at which the ball entered, a flat piece of lead, about one-fourth of an inch in diameter, the edge of which had come in contact with the radius, and was curled over, having evidently impinged against the bone; for small fragments of bone were impacted in the lead. This particle of lead was most probably detached from the ball during its passage through the thick plank; the remainder of the ball, as before stated, passed entirely through the fore-arm, between the radius and ulna. This fragment of the ball was surrounded by a thick fibrous capsule. The edges and sides of the wound, upon both surfaces, the internal and external (points of entrance and exit of the ball), were much thickened and hardened, and the bones along the track of the ball have evidently been injured. Owing to the severe spasms, which attempts at even slight examinations, induced, a thorough examination of the wound was not made until this time. The examination with the probe was not made when the patient first entered the hospital, for he had been wounded several days, and the wound appeared to be doing as well as usual in the most favorable cases. I made incisions upon both surfaces, through the thickened tissues, and introduced a tent, smeared with Basilcon ointment, for near one inch in the track of the wound; painted the surrounding parts with Tincture of Iodine, and ordered the fore-arm to be rubbed with the following liniment: ℞. Chloroformi, one fluidounce; Pulv: Camphoræ, four ounces; Tincturæ Opii, four fluidounces; Olei Olivæ, three fluidounces; dissolve the Camphor in the Chloroform and mix well with the other ingredients.

Has taken no Chloroform since 3 A. M. this morning. Ordered, that the Chloroform Mixture be stopped.

Examination of Urine.—Deep Yellow Color, Sp. Gr. 1019. Heavy deposit of Urates and Phosphates upon standing a few hours. Reaction, after standing twenty-four hours, strongly alkaline.

This is a decided change from the previous reactions, which were always acid, and continued so for several days. Similar changes are characteristic of the urine in the paroxysms of malarial fever.

No. 14.—*Analysis of Urine passed during* 24 *hours, July* 23*d,* 12 *M. to July* 24*th,* 12 *M.*

		Amount and Constitution of Urine passed during 24 hours. GRAINS.	Average amount and Composition of Urine passed each hour. GRAINS.
Amount of Urine		15,724.18	656.16
Urea		325.32	13.55
Uric Acid		20.83	0.85
Phosphoric Acid		17.79	0.74
Sulphuric Acid		23.97	0.99
Chlorine		107.79	4.49
Fixed Saline Constitu'ts	Entire Saline Constituents	326.00	13.58
	Phospates of Lime and Magnesia	22.20	0.92
	Phosphates, Sulphates and Chlorides of Alkalies.	303.80	12.65

July 25th, 12 M. Last evening, at 8 P. M., the patient says that he had "a very bad turn," "felt as if I was all drawn up, stiff, and unable to breathe;" and the muscles of the arm, back and body generally were spasomed.

The return of the spasms appeared to be due to the discontinuance of the Chloroform Mixture. The Chloroform Mixture was re-commenced immediately after the spasm; forty drops of this, with forty drops of Laudanum, produced some relief, and he fell asleep about midnight. This day he is quite comfortable. Pulse 76. The wound does not look so well; suppuration is somewhat diminished; urine light colored, with heavy deposit.

Continue the Chloroform Mixture, fifteen drops every hour, and administer an Enema of Salt, Molasses and Turpentine at once. The patient has been taking Brandy frequently, at short intervals during the attack, averaging about eight ounces each day. His diet also has consisted largely of Milk Punch.

Nine o'clock P. M. The Chloroform Mixture has produced good results. Ordered twelve grains of Calomel to be taken at once, and to be followed with one fluidounce of Castor Oil in the morning. Continue the Brandy and Chloroform Mixture.

July 26th, 12 M. The Calomel and Castor Oil produced the desired effect, and are still acting; patient says that he feels much better. The daily introduction of a tent smeared with Basilicon Ointment into the wound, has produced good results, causing the suppuration and the evacuation of a deep-seated abscess between the wound and the elbow joint. This morning this deep-seated abscess discharged suddenly, through the wound, several fluidounces of pus, to the great relief of the patient. After this, the swollen parts of the forearm, below the elbow, were sensibly reduced in size. Pulse 80.

Examination of Urine.—Orange colored; undergoes change rapidly, and gives off a putrid odor, and in a few hours loses the acid reaction, and lets fall a heavy deposit of Phosphates and Urates, Sp. Gr. 1016.

With the improvement of the general symptoms, there have been concurrent and marked changes in the urinary secretion, the color has diminished, and it has become more abundant, 33,666 grains having been excreted during the past forty-eight hours, and the acidity is much less, and it more rapidly undergoes the alkaline fermentation.

No. 15.—*Analysis of Urine passed during* 48 *hours, July* 24*th*, 12 *M. to July* 21*st*, 12 *M.*

	Amount and Composition of Urine passed during 48 hours.	Average Am't and Composition of Urine during 24 hours	Average Am't and Composition of Urine passed each hour.
	GRAINS.	GRAINS.	GRAINS.
nt of Urine	33,665.12	16,832.56	701.35
	745.75	372.87	15.53
Acid	16.63	8.26	0.34
horic Acid	27.97	13.98	0.58
uric Acid	26.41	13.20	0.55
ine	128.07	64.03	2.66
alent Chloride of Sodium	210.10	64.03	2.66
Entire Saline Constituents	508.40	254.20	10.59
e Phosphates of Lime and Magnesia	46.40	23.20	0.96
itu'ts Phosp'es, Sulp'es and Chlorides of Alkalies	462.00	231.00	9.62

e o'clock P. M. Has been taking only ten drops of the Chloroform Mixture, each hour g the day, and has intermitted several times, so that not more than sixty drops have administered.

pains, and contractions, and spasms of the arms and legs and back have commenced ; the diminution of the Chloroform has been attended with a return of the spasms. The toms, however, have been very mild, and for the first time since his attack he has been to stand upon his feet, and to walk across the ward, supported on either side by assist- Pulse 76. The purgative last administered has acted nine times.

rty drops each of Laudanum and Chloroform, with one fluidounce of Brandy, were nistered, and the Chloroform Mixture ordered regularly, ten drops each hour.

y 27th, 10 o'clock A. M. Rested well after midnight; all the symptoms appear to have oved; pulse 76; urine light colored.

ntinue Chloroform Mixture, ten drops each hour.

y 28th, 12 o'clock M. Continues to improve; the swelling in the arm has almost entirely ded; says that he feels quite well, with the exception of stiffness in the muscles, and pain between the shoulders, and "is hungry all the time." Pulse 84; bowels readily d by purgatives; were moved freely yesterday, and "feel as if they would be moved again."

mination of Urine.—Light yellow normal color. Specific gravity, 1014.5. Heavy light w deposit after standing twelve hours. This deposit forms a crust along the sides and e bottom of the glass vessels in which the urine is received, as in the urine excreted g the intermission of malarial fever.

No. 16.—*Analysis of Urine passed during* 48 *hours, July* 26*th*, 12 *M. to July* 28*th*, 12 *M.*

	Amount and Composition of Urine passed during 48 hours.	Average Amount and Composition of Urine passed each 24 hours.	Average Amount and Composition of Urine passed each hour.
	GRAINS.	GRAINS.	GRAINS.
nt of Urine	39,940.86	19,920.43	830.01
	864.50	432.25	18.01
Acid	23.62	11.81	0.49
phoric Acid	57.53	28.76	1.19
huric Acid	23.75	11.87	0.49
rine	189 13	94.56	3.94
valent Chloride of Sodium	310.16	155.08	6.46
l Entire Saline Constituents	371.62	185 81	7.74
e Phosphates of Lime and Magnesia	39.12	19.56	0:81
tituents Chlorides, Phosphates and Sulphates of Alkalies	332.50	166.25	6.92

M. Continues to feel "Quite comfortable." Complains only of a slight cough, and in the muscles of the back—most probably the result of the severe tension of the mus- during the previous spasms.

y 29th. Continues to improve, and walks, unaided, about the ward.

y 30th. Continues to gain strength; wound looks well, and is rapidly healing. Amount rine excreted from July 28th, 12 M., to July 30th, 12 M, (forty-eight hours), Grains, 6.70. Specific gravity, 1016; normal yellow color.

P. M. Has taken no Chloroform this day; Brandy in small quantities has been administered every three or four hours. Has experienced no ill effects from the cessation of the Chloroform. Temperature of Axilla, 40°.2 C. (104°.4 F).

I was unable to assign any cause for this increase of temperature, as the patient manifested no special increase of pulse or respiration, and complained of no febrile symptoms.

July 31st. Walks about; says that he feels perfectly well; tongue clean; urine normal in appearance; has taken no Chloroform during the last two days; takes nothing but a teaspoonful of brandy every three or four hours.

August 1st, 12 M. Patient appears to be entirely restored. The improvement of the arm has been very rapid; the symptoms of irritation, inflammation and swelling have almost entirely disappeared, and the wound is nearly closed. Takes no medicine, except a little Brandy occasionally. Bowels moved regularly each day; pulse 84; respiration 20.

The intermittent action of the pulse has disappeared entirely, with the disappearance of the spasms. Urine normal in color.

Specific Gravity of urine, 1013.

Reaction of urine, acid, when first passed, but it rapidly changes to the alkaline reaction after standing a few hours. During the height of the disease, on the other hand, the urine often retained its acid reaction for several days.

No. 17.—*Analysis of Urine passed during 24 hours, July 31st, 12 M. to August 1st 12 M. (24 hours.)*

		Amount and Composition of Urine passed during 24 hours.	Average Amount and Composition of Urine passed each hour.
		GRAINS.	GRAINS.
Amount of Urine		28.060.10	1,169.17
Water		27,190.53	1,132.94
Solids		869.57	36.23
Urea		543.48	22.64
Uric Acid		11.46	0.47
Phosphoric Acid		15.98	0.66
Sulphuric Acid		20.62	0.85
Chlorine		120.30	5.01
Equivalent Chloride of Sodium		197.47	8.22
Fixed Saline Constitu'ts	Entire Saline Constituents	296.52	12.34
	Phosphates of Lime and Magnesia	18.64	0.77
	Phosphates, Sulphates and Chlorides of Alkalies	278.08	11.58

This patient continued to gain strength; the wound healed up; and he was sent home on a furlough, ten days after the preceding observation.

This patient was treated in the General Hospital, Augusta, Ga.

The following observations and conclusions have resulted mainly from the study of the preceding case; and as this example should be accepted as a type of Traumatic Tetanus, as occurring in Military and Civil practice, these observations and conclusions may be regarded as general in their nature and application.

The essential phenomena of Inflammation and Fever were absent; the symptoms were exaggerated manifestations of nervous and muscular actions, rather than results of structural alterations; an irritation in a distant nervous branch, was propagated to the spinal cord, and the disease after its establishment, appeared to be dependent upon an undue excitability, and increased action in the entire spinal ganglia as manifested in the greatly exaggerated reflex actions; the disturbance or increased activity of the ganglionic cells of the spinal cord, was reflected to the sympathetic nervous system, inducing deranged action of the heart, obstinate constipation of the bowels, and increased activity of the skin.

TEMPERATURE IN TRAUMATIC TETANUS.

Elevation of Temperature, dependent upon, and accompanied with increased chemical action, is characteristic alike of Inflammation and Fever.

In the case of Traumatic Tetanus, now under consideration, there was increased chemical change in the nervous and muscular structures, without corresponding elevation of temperature. The temperature remained stationary or varied within small limits from those of health, and the normal relations, between the temperature of the trunk and extremities were preserved, and none of the perturbations of temperature characteristic of the various forms of fever and inflammation were at any time observed in this case; whilst at the same time, there were great nervous excitation and muscular action, and these actions were attended with marked increase of chemical action, as manifested in the constitution of the Urinary excretion. The slight elevations and perturbations of temperature may be accounted for, by the increased actions of the muscles. I have produced (as will be elsewhere shown,) similar slight elevations and perturbations of temperature in animals, by exciting tetanic spasms of the muscles, by the administration of strychnia, and by passing strong interrupted electrical currents through the spinal axis. In these experiments as well as in the present case, the elevation of temperature during the muscular agitation, was slight, and not at all like the great elevations and changes, and in some cases depressions of temperature characteristic of Fevers and Inflammations.

The philosophical explanation of the remarkable phenomenon, of the existence of active and increased chemical change in the muscles and nervous structures, without a corresponding elevation of temperature, is that, the result of these increased chemical actions, was the generation of the mechanical force of the muscular structures. The force generated by the increased chemical change in the central ganglionic motor cells of the spinal cord, excited the muscles to violent contractions, and was thus expended in accomplishing mechanical motion, and was not therefore, manifested as heat. Without this application of the forces, generated by the nervous and muscular apparatus, heat or some other mode of force would have been manifested. The correlation is thus established in the living body, between chemical change, and nervous muscular or electrical action.

In the elevation of temperature in Fever and inflammation, there is in like manner increased chemical change, but it takes place chiefly in the blood, and results in the development of *heat*, rather than in the generation of nervous and muscular force. And even when there are increased chemical changes in the nervous and muscular systems in Fever and inflammation, the resulting nervous and muscular forces are irregular in their application and manifestations, because the chemical changes take place, as it were, at random in all parts of the structures—in the blood, in the capillaries, in the ganglionic cells, in the commissures and nerve fibres, and in and around the muscular fibres; and as a necessary consequence, the resulting forces, heat, electricity, and nervous and muscular force, however great, cannot be correctly directed and applied. And hence, the irregular and depressed character of the forces in fever and inflammation. According to the view now presented, the muscular and nervous systems, are nothing more, than apparatus, for the application of the forces developed by chemical change to the accomplishment of such results, as sensation, locomotion, circulation, excitation and control of secretion, by the control of the supply of blood circulating through the organs, and by the transmission of impulses of physical force.

It is important to determine whether the absence of an elevated temperature be characteristic of Traumatic Tetanus; for whilst the intrinsic value of carefully and honestly recorded observations, is almost universally admitted, at the same time the importance of deductions and general conclusions, must rest upon the universality of their application to the expression or explanation of physiological and pathological phenomena.

As far as my experience in civil and military practice extends, in those cases of uncomplicated Traumatic Tetanus, which recovered, as a general rule the temperature, as in the case just recorded (No. 1,) was elevated but slightly above the normal standard, and did not manifest the marked elevations and perturbations characteristic of the Pyrexiæ and Phlegmasiae. This proposition will be still further illustrated, by the following cases.

Case No. 2: Traumatic Tetanus; Treated with Bromide of Potassium and Cannabis Indica; Recovered.

C. E. I.—Negro coachman; age twenty-one years; strong and well built. May 7th, 18[illegible], received an injury, (penetrating wound) of sole of left foot; wound healed, apparently, in about one week.

May 24th, lower extremities got wet whilst driving in the rain; May 24, symptoms of Tetanus appeared, viz: Trismus, difficulty in swallowing, and contraction of abdominal muscles.

Entered Charity Hospital May 27th. Jaws quite firmly locked; speaks and swallows with difficulty; respiration impeded; surface bathed with profuse perspiration; the expression of the face denotes great contraction of the muscles of the jaws (risus sardonicus). Abdominal muscles contracted. Bowels obstinately constipated; urine scant; tongue coated. One-third of a grain of Sulphate of Morphia was injected hypodermically, and repeated at intervals, but without apparent benefit. The muscular contractions of the muscles of the abdomen and back increased, with frequent spasms, and decided opisthotonos. Was thrown into violent spasms whenever the attempt was made to lie on the left side. The attending physician placed the patient, on 31st of May, upon full doses of Bromide of Potassium and Tincture Cannabis Indica: From half a drachm to one drachm of the Bromide of Potassium, combined with from one to two fluiddrachms of the Tincture of Cannabis Indica were administered every two, three, four and six hours, according to the severity of the symptoms.

Up to June 3d, the trismus, spasms and opisthotonos were well marked, and the patient unable to sleep; but the beneficial effects of the treatment appeared to be manifest during the night of the 3d, when the patient slept. On the 4th of June, the effects of the Bromide of Potassium and Tincture of Cannabis Indica were still more decided; the patient swallowing with comparative ease, the spasms diminishing in intensity. On 5th June, had good action from the bowels. Continues to improve; spasms less in severity, and occur at longer intervals; and the patient is able to sleep continuously from one to two hours at a time. Continued to improve up to June 13th, when there was a slight increase in the severity of the spasms; and the intellect wandered, apparently from the long continuance of the Bromide of Potassium, and Tincture Cannabis Indica. 28th of June, was able to dress himself and walk about the ward.

The following is the record of the Temperature, Pulse and Respiration:

June 5th, Temperature of the Axilla in the evening, 101°.4 F; Pulse, 100; Respiration, 48.

June 6, Temperature, A. M., 99°.[illegible] F.; Pulse, 88; Respiration, 30. P. M., Temperature, [illegible] F; Pulse, [illegible]; Respiration, 44.

June 7, A. M., Temperature, 99°.3 F.; Pulse, [illegible]; Respiration, 34. P. M., Temperature, [illegible] F; Pulse, 84; Respiration, 38.

June 8, A. M., Temperature, [illegible] F; Pulse, 84; Respiration, 30. P. M., Temperature, 100° F; Pulse, 84; Respiration, 34.

June [illegible], A. M., Temperature, [illegible]; Pulse, 84; Respiration, 32.

June [illegible], Temperature, [illegible]; Pulse, [illegible]; Respiration, 34.

June [illegible], Temperature, [illegible]; Pulse, [illegible]; Respiration, 32.

June [illegible], Temperature, [illegible]; Pulse, [illegible]; Respiration, [illegible].

June [illegible], Temperature, [illegible]; Pulse, [illegible]; Respiration, [illegible].

June [illegible], Temperature, [illegible]; Pulse, [illegible]; Respiration, [illegible].

June [illegible], Temperature, [illegible]; Pulse, [illegible]; Respiration, 32.

June [illegible], Temperature, [illegible]; Pulse, [illegible]; Respiration, [illegible].

June [illegible], Temperature, [illegible]; Pulse, [illegible]; Respiration, [illegible].

June [illegible], Temperature, [illegible]; Pulse, [illegible]; Respiration, [illegible].

June [illegible], Temperature, [illegible]; Pulse, [illegible]; Respiration, [illegible].

June [illegible], Temperature, [illegible]; Pulse, [illegible]; Respiration, [illegible].

June [illegible], Temperature, [illegible]; Pulse, [illegible]; Respiration, [illegible].

June [illegible], Temperature, [illegible]; Pulse, [illegible]; Respiration, [illegible].

The [illegible] was [illegible] varying from thirty-two to sixty fluid[illegible] The specific gravity varied from 1023 to 1030. The [illegible] The temperature and [illegible] notes in this case were taken [illegible] of New Orleans, at that time Resident Student, Charity [illegible]

[illegible] notwithstanding the existence of well marked symptoms of [illegible] the highest point which the temperature reached was only [illegible]

Case No. [illegible]: Traumatic Tetanus; Treated with Sulphate of Morphia and [illegible]; Recovery.

[illegible] native of New Orleans; laborer. Admitted to the Charity Hosital, June 4th, 1873, with incised wound of left foot, caused by jumping from a steamship a nail.

The iron nail passed through the shoe. A piece of leather was taken out of the wound, nd the patient discharged on the 5th. Re-admitted to Charity Hospital June 19th. Patient ys, that after leaving the hospital, he slept in a low, damp room, on bare wooden floor; une 17th, experienced pain in the small of the back, radiating to back of neck, jaws and de; June 18th, stiffness of jaws, slight spasms, difficulty in swallowing, restlessness and eeplessness; 19th, Trismus; tongue coated; bowels obstinately constipated; skin bathed profuse perspiration; slight spasms excited by movements of any kind. The spasms mmence with a quivering of one or the other leg. Urine scant and high colored; intellect ear.

The patient was placed upon Sulphate of Morphia, from one-sixth to one half grain every o, four or six hours, according to the symptoms. The effort was made at the same time to ep the bowels open, by the use of purgative enemas and the internal administration of oton Oil. June 20th, Opisthotonos well marked, patient perspiring profusely; the spasms d opisthotonos continued with varying degrees of intensity, until the 5th of July, when ere was marked improvement. The following is the record of the Pulse, Temperature d Respiration.

ATE.	PULSE.		RESPIRATION.		TEMPER'TURE AXILLA.		AMOUNT OF URINE IN FLUIDOUNCES	SPECIFIC GRAVITY OF URINE.	REMARKS.
873.	8 A.M.	6 P.M.	8 A.M.	6 P.M.	8 A. M.	6 P. M.			
ne 20		80				100 F			Opisthotonos: Profuse Perspiration: Trismus.
21	72	84	22	22	101.5	101.5	16	1024	Profuse Perspiration; Bed clothes drenched.
22	90	92	18	24	102	99.5	18	1025	Bowels moved; Profuse Perspiration.
23	84	84	22	22	100	100.5	16	1024	Symptoms much the same—Constipation.
24	96	86	24	28	100	101	16	1025	Muscles of Back greatly Contracted; body arched.
25	86	86	28	24	101	100	16	1025	Restless and Anxious; severe spasms of legs; Cons'd
26	80	84	28	30	101	101	16	1025	Delirious during night, with involuntary twitchi'gs
27	82	90	32	24	101	101	16	1025	Intellect clear; Opisthotonos less; appears better.
28	80	86	22	24	100.5	101	16	1025	Slight improvement.
29	84	86	26	26	100.5	101	20	1025	Slept well during the night.
30	84	84	26	24	99	100	16	1025	Continues quiet comparatively; Spasms less.
ly 1	84	94	24	28	100	100.5	30	1015	Muscles more relaxed; Reaction of Urine Alkaline.
2	88	86	24	26	100	100	22	1025	Urine has been acid up to this date.
3	86	88	26	24	100	100	24	1015	Opisthotonos disappearing.
4	88	88	28	26	100.5	101	48	1015	Muscles of body and neck relaxing gradually.
5	80	86	30	26	100.5	101	136	1025	Respiration not so profuse; Urine abundant.
6	88	88	24	26	100	100	136	1025	Improving; hæmorrhage from nose.
7	88	88	30	28	100	100	112	1025	Muscles relaxed; improving; Urine abundant.
8	88	86	32	30	100	101	48	1015	Convalescent, suffers only from muscular pains and [stiffness in back.
9	88	88	28	28	100	101	72	1015	Convalescent.
10	84	86	30	28	100	100	104	1020	Convalescent; Spasms Opisthotonos have disappe'd.
11	86	86	28	28	101	100	120	1015	" " " "
12	88	86	26	26	100	99	128	1015	" " " "
13	86	88	26	28	100	99.5	128	1015	Sat up in chair for four hours.
14	88	86	28	26	100	99.5	75	1010	Continues to gain strength.
15	86	86	26	26	99.5	100	120	1015	Patient up and walking around the ward.
16	88	86	28	28	100	100	110	1015	Patient up and walking around the ward.
17	86	86	24	26	100	100	88	1010	
18	88	88	28	28	100	100	80	1010	
19	88	84	28	24	100	99.5	86	1015	
20	84	84	26	24	99	99	64	1020	
21	84	86	26	26	99	99.5	48	1025	
22	86	86	26	22	99.5	100	80	1015	
23	84	84	24	24	100	100	72	1020	
24	84	80	22	20	100	100	64	1015	
25	80	80	20	20	100	99	64	1015	
26	80	78	20	20	99.5	99.5	64	1020	
27	76	76	20	20	99	99	64	1020	
28	76	74	20	20	99.5	99.5	64	1015	
29	74	74	20	20	99.5	99	44	1025	

On the 31st of July, this patient was discharged from the hospital at his own request. The clinical notes of this case were taken for me, at my request, by Dr. William Martin, f New Orleans, at that time Resident Student of Charity Hospital.

In Case No. 3, the highest point of temperature reached, was 102° F., and this con- inued only for a short time. As in the preceding cases, the temperature was but lightly elevated above that of health, and the oscillations were confined within small imits.

It is important to determine whether the absence of an elevated temperature be haracteristic of Tetanus, as observed by others.

That Hippocrates* had carefully observed the phenomena of Traumatic Tetanus, is evident, from the prognostic, or aphorism, that " *Spasm supervening upon a wound, is mortal,*" and " *Such persons as are seized with Tetanus die within four days, or if they pass these they recover.*"

In those cases of Tetanus which Hippocrates recorded in his Treatise on Epidemical Diseases, he not only makes no allusion to any elevation of temperature, but advocates that form of treatment which is applicable to depression of animal temperature, as in the following quotations from his works:

CASE No. 4.—" Scamandrus, in Larissa had a *mortification* in his hip, and an *abscess* of long standing at the bone. A large incision being made, even to the bone, and ustion used afterwards, a convulsion began the twelfth day after the incision, and held him strong, reaching from the leg to the ribs, and affected also the other side. The leg was sometimes contracted, sometimes extended, and he had the use of his other limbs, but his jaws were set. The eighth day after the first convulsion, he died in another. The cure was carried on by applying *warm bottles* and *fomentations of tares* to the whole body, not omitting a glyster; by which the fæces that had been long detained came away in a small quantity. He also drank a *bilious purge*, and even a second; from which, indeed, there was a discharge, but to no advantage. After a little sleep, he took another *strong purge* of the like kind, and in the evening died about sunset; but in all probability might have held out a long time, had not the physic been too strong for him."

CASE No. 5.—" Another received an insignificant wound to speak of (for it was not deep), a little below his neck, behind, from a sharp dart; which being taken out not long after, he was drawn and distorted backwards, as in the *opisthotonos*. His jaws were also fastened; and if anything moist was put into his mouth, and he attempted to swallow it, it retured again through the nose. In other respects he grew worse immediately. The second day he died."

CASE No. 6.—" The Master of a great ship had the fore-finger, and the lower bone of his right hand broke to pieces. An inflammation came on, a mortification and a fever. The fifth day he was purged moderately; the heat and pain abated, and part of the finger fell off. After the seventh, a little gleet came away; and after this he said he could not pronounce his words plain. A prediction was made that that kind of convulsion which draws one backward, would happen; to which contributed the jaws being set and drawn down to the neck. The *third* day the above mentioned convulsion seized him all over, and he sweated. The sixth day after the prediction he died."

CASE No. 7.—Telephanes, son of Harpalu's freed woman, received a wound or bruise in his great toe. An inflammation came on, with a vast deal of pain. Upon its abating, he went into the field, and as he was going, a pain took him in his loins, for which he used bathing. At night his jaws were set, and the convulsion that draws one backwards, seized him. What he spit was frothy, and came from him through his teeth with difficulty. The third day he died."

CASE No. 8.—"Zeno, the son of Damon, had an ulcer about the bone of the leg, or ankle, by the tendon that was now grown clean. Upon the application of a corroding medicine, he fell into convulsions of the opisthotick kind and he died." *Hippocrates Upon Air, Water and Situation. Epidemical Diseases, and upon Prognostics.* Trans. by Francis Clifton, M. D., London, 1734, pp. 156, 167, 199, 200.

In the following directions for the treatment of Tetanus, it is evident that Hippo-

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* (Economia Hippocratis, Alphabeti Serie Distincta. * * Anutio Fœsio Mediomatrico Medico Authore; Francofurdi, apud Andreæ Wecheli heredes: 1588.

The Works of Hippocrates, in Latin and Greek, edited by Anutio Fœsio, and published at Frankfort, by Andræ Wecheli herdes; 1595.

Hippocratis Coi Ascelpiadæ gentis sacræ Coryhaei Viginti duo commentarii Zabulis illustrati; Græcus Contextus ex doctis. VV. Codicibus emendatus, etc. Theod Tuingeri Bas Studio et Conatu, Basileæ Episcopiorum Opera Atq. 1579.

Hippocratis Coi Aphorismi Graecè et Latinè Johannis Heurnii. Raphelengii. 1607.

Magni Hippocratis Coi Opera Omnia Graece and Latine edita, et ad omnes alias Editiones accommodata. Joan Antonidæ Vander Linden, Doct. et Professoris Medicinæ Practicæ Primi in Academia Lugduno, Batava, 2 vols. Lugduni Batavorum, Apud Danielem Abrahamum et Adrianum à Gaashbeeck. 1665.

Hippocrates Upon Air, Water and Situation; Upon Epidemical Diseases, etc. Trans. by Francis Clifton, M. D., London. 1734,

The Genuine Works of Hippocrates; Trans. by Francis Adams, LL. D., 2 Vols., London. 1849.

considered Fever as an unusual symptom in the disease, and as in no manner
cted with its production.

> hen the loins are in a tetanic state, and the spirits in the veins are obstructed by mel-
> lic humours, venesection will afford relief, but when, on the other hand, the anterior
> s are strongly contracted, and if there be sweats about the neck and face, extorted by
> lent pain of the parched and dried tendons of the sacral extremity (these are very
> sustaining the spine, and giving rise to very great ligaments, which terminate in the
> n such a case, unless fever and sleep come on, followed by concocted urine and criti-
> eat, give to drink a strong Cretan wine, and boiled barley meal for food; annoint and
> ith ointment containing wax; bathe the legs and feet in hot water, and then cover
> p; and so in like manner the arms, as far as the hands, and the spine, from the neck
> sacrum, are to be wrapped in a skin smeared with wax; this must extend to the parts
> l, and intervals are to be left for applying fomentations, by means of leather bottles
> with hot water; then, wrapping him up in a linen cloth, lay him down in bed. Do not
> the bowels, unless by means of a suppository, when they have been long of being
> . If there be any remission of the disease, so far, well, but otherwise pound of the
> f bryonia in fragrant wine, and that of the carrot, and give to the patient, fasting early
> morning before using the affusion, and immediately afterwards let him eat boiled bar-
> al in a tepid state, and as much as he can take, and in addition, let him drink, if he
> ine well diluted. If the disease yield to these means, so much the better, but if other-
> you must prognosticate accordingly." *The Genuine Works of Hippocrates.* Trans. by
> s Adams, LL. D., Surgeon. Vol. 1, p. 326.

tæus the Cappadocian, in his accurate and elegant description of Tetanus, makes
ntion whatever of fever amongst the symptoms; and treats the disease whether
from wounds, abortion or excessive cold, as a disease of the nerves, and recom-
castor and assafœtida as anti-spasmodics.

lus Ægineta, not only makes no mention of increased heat and fever, amongst
mptoms, but quotes Pelops, to the effect that *the most potent remedy for all the
ies of Tetanus, is a fever* supervening when there was none at the commencement.
pocrates, Plato, Galen, Horatianus and Avicenna agree in stating that a fever
g on tends to remove the tetanic affection; Cælius Aurelianus however, seems to
on the truth of this ancient aphorism.

wever imperfect and uncertain, the knowledge of the older medical writers may
been as to the functions of the nervous system, it is evident from the opposition
ny to the employment of cold affusions, and the almost universal advocacy, of the
emollient applications, tepid and warm water and oil baths, soporifics, and such
pasmodics as Castor and Assafœtida, by Octavius Horatianus, Avicenna, Mesue,
on, Haly, Abbas, Rhases, and other Arabian and Greek physicians, in the treat-
of Tetanus, that they regarded the disease as essentially different from fevers and
mations.

us A. Cornelius Celsus, treated Tetanus as a spasm of the nerves by local applica-
by warm emollient baths, and by careful attention to the maintenance of a warm
lly regulated temperature.

hn Brown, in his "Elements of Medicine," affirmed that

> tanus is an asthenia, and, therefore, always affects persons in a state of debility,
> er direct or indirect; and like every other asthenia, depends upon debility."

e treatment recommended by Brown, corresponded with this theory, thus:

> e must, therefore, immediately have recourse to the most powerful and the most diffu-
> timuli possible, and continue their use without regard to quantity, not even to that of
> itself, till the whole tumult of the disease is allayed." Elements of Medicine, DCLII.,
> V., DCLV.

lliam Cullen, held that Tetanus is seldom attended with fever, and the blood drawn
s disease never exhibits any inflammatory crust.

. Lionel Chalmers,* refers the more frequent occurrence of tetanic complaints in

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Account of the weather and diseases of South Carolina, by Lionel Chalmers, M. D.; London, 1786; pp. 23–31.

Autumn, to the lax and irritable or depressed state of the system, induced by the effects of climate.

Benjamin Rush* held that Tetanus

> "Is seated in the muscles, and, while they are preternaturally excited, the blood vessels are in a state of reduced excitement. This is evident from the feebleness and slowness of the pulse. It sometimes beats according to Dr. Lining, but forty strokes in a minute. By stimulating the wound, we not only restore the natural excitement of the blood vessels, but we produce an inflammatory diathesis in them, which abstracts morbid excitement from the muscular system, and, by equalizing it, cures the disease."

John Hunter, regarded Tetanus as non-inflammatory in its nature, and as arising from an irritable habit, but not such as is capable of producing inflammation.

In his observations on the treatment of Tetanus, John Hunter, lays down the principle that:

> "The first appearance of cure, is a recovery of strength, as weakness is a pre-disposing cause; and the first indication should be to strengthen the system." Works of John Hunter, edited by James F. Palmer, London 1837, vol. 1, pp. 583–589.

According to James Lind, Tetanus occurs most frequently in hot countries; and there appears to be no fault in the blood in such cases, nor an universal disorder in the solids, preying on the vital organs, or debilitating the principle of life, this being merely a local muscular spasm. *An Essay on Diseases Incidental to Europeans in Hot Climates.* London 1768, pp. 257–259.

Dr. James Currie, who more than sixty years ago, advocated strenuously, and frequently employed the thermometer in the Diagnosis and treatment of diseases, in that portion of his Medical Reports, which relates to the effects of water, warm and cold, as a remedy in Fevers and other diseases, remarks upon the nature and treatment of Tetanus:

> "It is deeply to be lamented that this disease should ever have been considered as of an inflammatory nature, and that there are even now, physicians who treat it by venesection. It is in my mind decisive against this supposition, that though the general system is so powerfully affected, the animal heat is not increased which, it uniformly is, so far as my observations extend in all cases where there is an inflammatory affection of the system, whether originating or terminating in local phlegmonic inflammation. The same consideration is decisive with me as to the supposed inflammatory nature of hydrophobia, a notion which respectable physicians have lately revived. Of this most singular and affecting disease, I have seen five cases, in none of which was there any increase of animal heat. All these terminated fatally. Hydrophobia has some resemblance to tetanus, but is however in my judgment obviously and essentially different." *Medical Reports, Philad., p.* 133.

The cases of Traumatic Tetanus reported by Benjamin Travers† in his *Inquiry concerning Constitutional Irritation*, were unattended by fever, and the blood presented no marks of inflammation, and both his pathology and treatment are based upon the view that *It is essentially a disease of function, and destroys by exhaustion, if not by sudden translation of the spasm to the heart.*

The late Dr. Robert Bently Todd, in his valuable article on the Nervous System, contained in the 3d volume of the *Cyclopædia of Anatomy and Physiology*, and in his more recent *Clinical Lectures on Diseases of the Nervous System*, held the view that Tetanus consists not in an inflammatory condition of the cord and its membranes, nor in congestion of them, but simply in a state of prolonged physical excitement; the natural polar force of the central ganglia, being greatly exalted, and kept so by the constant irritation propagated to them by the nerves of the injured part.

Mr. O. Burne, states that amongst about two hundred cases of Tetanus, which he had witnessed, not one was accompanied by fever.

Dr. John D. Jackson, of Danville, Kentucky, has given the details of an interesting

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[*] Medical Inquiries and Observations. Vol. 1, pp 256–257.

[†] A Farther Inquiry Concerning Constitutional Irritation, by Benjamin Travers. London, 1835, pp. [illegible], [illegible].

case of Traumatic Tetanus, (Richmond and Louisville Medical Journal, November, 1871, pp. 484–493,) which occurred in a negro boy, aged 14, from a wound of the foot by a piece of glass; and in which the daily record of the temperature showed with the exception of three days, the *absence of anything like a febrile condition*, and that the heat of the patient "was rather *sub-normal* than the reverse." The highest point reached in this case was 100°. F. on the 6th day, and the temperature of the axilla from the 25th of August to the 8th of September oscillated, with the single exception mentioned from 97 to 99°. F.

Dr. Jackson also states that in two other cases in which he had noted the temperature, it did not reach above 101°. F.

The number of recorded observations upon the temperature in Tetanus is very limited, and we have searched in vain for accurate thermometric determinations in the writings of many distinguished Army and Navy Surgeons, as Pringle, Blane, Trotter, Hennen, Abernethy, Guthrie, Larrey, Baudens and Macleod.

The weight of medical testimony is therefore to the effect, that the symptoms of *Fever and Inflammation*, are almost universally absent in Tetanus.

That in some cases of Traumatic Tetanus, the temperature is elevated considerably above the normal standard, is evident from the following observations:

CASE 9.—*Traumatic Tetanus; rapid rise of Temperature a short period before death.*

M. B., laborer; native of New Orleans, age 21. Patient received November 24th, 1873, gunshot wound through right foot; the ball making a hole of about half an inch in diameter on the dorsum, and about two inches in sole of foot, metatarsal bone of big toe shattered. Edges of wound ragged. Entered Charity Hospital, November 24, a short time after the reception of the wound. The splinters of bone were removed as far as possible, and the wound dressed with carbolic wash.

About nine days after the reception of the wound, viz: on December 3d, the patient complained of pain in the foot, and stiffness of the jaws. The wound has never discharged laudable pus, but has exuded an offensive sanious discharge. R. Tinct. Cannabis Indicæ three fluid drachms; Potassiæ Bromidi half ounce; Syrupi simplicis four fluidounces; tablespoonful every 3 hours. December 4th. symptoms of Tetanus well marked; trismus; rigid abdomen; opisthotonos; occasional spasms. P. M., Temperature, 99°. Respiration, 25.

December 5th. Symptoms more intense, bowels obstinately constipated. Temperature of Axilla in the morning, 99°. 5; Respiration 24. Urine scant, only two fluidounces during the 24 hours. In the evening the temperature of the axilla had risen to 108°. F. The patient died at 3 o'clock A. M., the next morning, December 6th.

The clinical notes in this case, were taken at my request, by Dr. C. Fred. Knoblauch, of New Orleans, and at that time Resident Student of Charity Hospital.

In the preceding case, it is worthy of note, that the case terminated fatally shortly after the temperature reached 108°. F. It is probable that the temperature of the internal organs, was between 110 and 111°. F.

CASE 10.—*Traumatic Tetanus; rapid rise of Temperature, sudden fatal termination.*
Reported by Dr. Y. R. LeMonnier, of New Orleans.

X, age 26 years, brick-layer; entered Hospital Pitié, Salle St. Louis, Paris, June 22nd, 1869; died, July 10th, 1869. This man entered the Hospital, for a dislocation of the thumb of the right hand, with a perforation of the bone through the skin. The dislocation had been reduced, and the wound was healing kindly, when on the evening of the 7th of July, (16 day of injury,) the first symptoms of tetanus showed themselves by an inability to completely open the mouth. When we saw the patient for the first time in the morning of July 9th, about 18 hours after the appearance of the first symptoms of Tetanus, opium and morphine, by the mouth and subcutaneously, had been freely administered. It was resolved to use woorara by subcutaneous injections. At 9 A. M., the axillary temperature 103°. 8; at 10 50 A. M. when the first injection of woorara was made, the pulse was 124 large, and compressible; Rectal temperature 106°. 8 F.; Respiration 40, short and intermittent. The spasms recurred every two or three minutes, between which the patient was able to rise and flex the extremities, and also to drink and urinate. The temperature was very high during the last 36 hours. The patient died on the 10th of July; at the hour of death the pulse was 168 and thready; respiration 44, and diaphragmatic, face cyanosed; general muscular contractions less marked at inferior extremities; pupils dilated; skin intensely hotto the touch, and apparently from 1[illegible]° to 11[illegible]° F. Having obtained no sedative effects from the subcutaneous injections of woorara, morphine in the same manner was again used on the last day, July 10th.

The following tables show the number of subcutaneous injections of Woorara and the state of the Pulse, Respiration and Temperature on July [illegible].

10:45 A. M., two sub-cutaneous injections Woorara ½ grain each in fifteen minims of water.
11:47 A. M., two sub-cutaneous injections Woorara ½ grain each in fifteen minims of water.
No marked effects; spasms continuing.
9 A. M., Pulse —— Temperature in axillary 1[illegible]° [illegible] Respiration ——.
10:50 A. M., Pulse 12[illegible] Temperature Rectum 1[illegible]° [illegible] Respiration [illegible] per minute.
11:20 A. M., Pulse 1[illegible] Temperature
12:15 P. M., Pulse 1[illegible] Temperature Rectum [illegible] Respiration [illegible] per minute.
12:3[illegible] P. M., Pulse 1[illegible] Temperature Rectum [illegible] Respiration [illegible] per minute.
1:2[illegible] P. M., Pulse 1[illegible] Temperature Rectum [illegible] Respiration [illegible] per minute.
1:4[illegible] P. M. Pulse 1[illegible]

The temperature continued to rise and the pulse to increase in frequency, and at the moment of death on the 10th of July it was estimated that the temperature ranged between 10[illegible]° and 1[illegible]° in the rectum, the pulse was [illegible] and thready, respiration [illegible] and diaphragmatic. Dr. Le Monnier desired to determine the changes of temperature after death, but through a mistake, the body was removed immediately from the ward.

Post-mortem twenty-four hours after death. Dr. Le Monnier was not present at the post mortem examination, but the following is the result as given to him by M. Le Prof. Broca, attending surgeon. *The cervical portion of the spinal cord was [illegible] and softened down into a cream-like substance, [illegible] cervical nerves, right side.* The anterior or motor roots of the nerves in this portion of the cord were also altered and softened, whilst the posterior roots appeared to be normal. The softening was most marked at the roots of the fifth pair.

The Tetanus was caused by an irritation of a collateral branch of the median nerve of the thumb, excited, apparently, by friction against a rough, bony surface on the external side of the inferior extremity of the thumb. This extremity had been crushed by the accident. The head of the metacarpal bone at its [illegible] surface was partly fractured.

The case just recorded is important in that an elevated temperature and rapid, fatal result in Traumatic Tetanus, were attended with rapid circulation and respiration, and with inflammatory softening of the cervical portion of the spinal cord.

Dr. Le Monnier informs us that he observed a similar condition of the spinal cord in one of his dogs, which died from the effects of Traumatic Tetanus, caused by a penetrating wound of one of the [illegible]. Although the temperature in the animal was not accurately noted by the thermometer, it nevertheless appeared by the sense of touch to be considerably elevated above the normal standard.

CASE NO. 11.—M. Prevost, of Geneva, had a patient, a boy twelve years of age, afflicted with Tetanus, which was accompanied by an extraordinary development of heat. A thermometer placed in the axilla was raised to 110°.75 F. If the original temperature be reckoned at 9[illegible]°.2, there was an elevation of 12°.5 Fahr.

CASE NO. 12.—In a case of Traumatic Tetanus described by Dr. Bright, the temperature in the axilla on the third day was 10[illegible]° F.

CASES 13 AND 14.—Dr. James Copland* observes, that the "amount of animal heat necessarily varies in different cases—probably from 10[illegible]° to 106°. F. I observed it 10[illegible] in the axilla on the second day of a case which terminated fatally on the fourth day, and 10[illegible]° in another which died on the third day." After a careful examination of the entire article on Tetanus, by Dr. Copland, we have failed in finding any accompanying observations which would enable us to determine whether or not there was any fever or inflammation preceding or accompanying the Tetanus, which would account for this increase of animal heat. According to Dr. Copland,

† The pulse in Tetanus has been variously described by different authors. This has been owing chiefly to the different states of the heart's action in the several states or stages of the disease, and the varying grades of frequency in the acute and sub-acute cases, as well as in the idiopathic and symptomatic forms of the malady. Drs. Morrison, Hennen, Macgregor and others have remarked that the pulse is seldom much affected; but the greater number of writers have stated the pulse to be very much accelerated, and most remarkably so in acute

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* Dictionary of Practical Medicine. New York; 1859. Vol. iii. p. 1104.

cases. This is the result of my own observation in the numerous cases which I have had an opportunity of observing in France and Germany, in 1815 and 1816, and subsequently in warm climates. In an acute case which I attended in 1820, the pulse was 120 in the minute, in the first day of the developed attack. The patient died on the third day. The pulse is generally much less frequent during the intervals than in the paroxysms, but the degree of frequency varies in different cases, as well as in the course of the disease. The treatment adopted has often a considerable influence in quickening the pulse, and towards a fatal issue this is especially the case. The changes taking place in the spinal cord, medulla, etc., and their membranes, according to their nature and amount, also influence the pulse. As the powers of life sink, or are depressed by sedative agents, as by tobacco injections, etc., the pulse becomes remarkably quick, and often feeble. Both the pulse and respiration are greatly accelerated by the spasms, and hence are varied in character and in quickness, with their severity and frequency of accession. During their continuance, especially towards the close of the malady, the pulse is often so frequent, weak and irregular as not to admit of being accurately counted, while the respiration is labored, or gasping." p. 1104.

Thomas Blizard Curling, in his valuable *Treatise on Tetanus*, says that:

"It is true that in some instances, even of the traumatic form of the disease, fever has been present, and the blood has been found cupped and buffed; but in nearly all such cases the symptoms of Tetanus are independent of those of inflammation. The latter sometimes coexisting with the former, but arising from distinct, and often accidental causes, as in case 10, in which the wound was so severe as to occasion inflammation at the seat of the injury; or, as in case 89, where pleuritis supervened after the accession of the spasm. It will, however, be shown hereafter, that tetanic symptoms may result from inflammatory action in the medulla spinalis, which rarely occurs in the traumatic, but is occasionally the cause of the idiopathic disease.

Inflammation and fever, therefore, when present, must not be viewed as the necessary effects of the spasmodic disease." *Treatise on Tetanus;* Phila., 1837; p. 19.

CASES 15 AND 16.—In a case of Traumatic Tetanus, which occurred in the practice of Mr. T. Holmes, of London, (reported in the article on Traumatic Fever, by Mr. John Croft; System of Surgery, 2d. Ed., Vol. 1, pp. 297, 299), the disease appeared whilst the patient was suffering with traumatic fever, consequent upon a spike wound of hand. The temperature declined from 101°4 F., on the third day, to 98°6, on the fifth day, when it gradually rose to 102°.4, on the sixth day, when Tetanus supervened and proved fatal, on the evening of the seventh day after the reception of the injury, when the temperature had reached 104°.8 F.

In this case, the temperature had commenced to rise before the appearance of Tetanus, and it is impossible to determine, from the meagre report of the case, whether the progressive rise after the appearance of tetanic spasms, was due to the supervention of this disease. It would be more reasonable to refer the rise of temperature to the same causes as those which had induced the traumatic fever, for in another case, (which occurred in the practice of Mr. Holmes, and which is quoted in the same work), of traumatic fever, caused by a gunshot wound of the hand, the temperature stood at 102°.4 F., upon the evening of the second day, and then rose to 103°.6 F., on the morning of the third day, when trismus appeared. The temperature fell, upon the evening of this day to 100°.4 F., and rose again to 102°.6 F., on the morning of the fourth day, descending in the evening to 101°.5 F., and continuing to descend and falling to 100°.8 F., on the morning of the fifth day, and rising again to 102°.8, on the morning of the sixth day, and with slight oscillations, descending to the normal temperature 98°.2, on the morning of the 14th day, when the trismus as well as the traumatic fever disappeared. If the oscillations of the temperature in these two cases of wounds, in which Tetanus supervened upon Traumatic or Hectic Fever, be compared with the thermometric record in the same work, only negative inferences can be drawn as to the effects of Tetanus in increasing or diminishing the febrile excitement. More extended and critical observations are needed, before the relations of the traumatic spasm to the rise or fall of pre-existing Hectic Fever, can be accurately determined. Thus, it is very evident that the rise of the fever in the first case, might have been due to other causes, as the extension of the irritation to other organs, and to an increased absorption and diffusion of the inflammatory products. Precisely similar oscillations of temperature have been recorded in cases of Traumatic Fever, in which no tetanic symptoms supervened.

Wunderlich, first drew attention to a peculiar symptom, which has been since confirmed by several observers, (Billroth, Leyden, Ebmier, Ferber, Erb, Quincke, and Monti); namely, that in the last stages of fatal neuroses, and more particularly in tetanus, although met with in very many other disorders of the nerve-centres, (of the brain,) the temperature begins to rise, and rises in the briefest space of time to extraordinary heights; to heights indeed, which are only exceptionally reached in diseases which are of distinctly febrile origin, sometimes to 43° C. (109°.4 Fahr.) or even to above 44° C. (111°.2 Fahr.) and in one case of Tetanus to 44°.75 C. (112°.55 Fahr.), which is usually succeeded by a still farther post-mortem rise of temperature, amounting to a few tenths of a degree. Fifty-seven minutes after death, the temperature in the case of Tetanus observed by Wunderlich, amounted to 45°.375 C. (113°.675 Fahr). Lehmann, noted 44°.4 C. (111°.9 F.), in a case of tetanus just before death. Her Hofrath *Unterberger*, Professor of Vetinary Surgery in Dopart, informed Professor Wunderlich, in a letter, that he had observed temperatures of above 42° C. (107°.6 Fahr.,) in fatal cases of Tetanus in Horses.

Such elevations of temperature have been but rarely observed in disease: Currie found a temperature of 44°.45 C. (112° F.) in a case of Scarlet Fever: Simon observed 44°.5 C. (112°.1 F.) in a case of Variola Hæmorrhagica, although, indeed the temperature was taken after death; Quincke 44°.3 C. (111°.74 Fahr.,) in a case of Acute Rheumatism; Brodie in a case of destruction of the lower cervical portion of the spinal marrow, 43°.9 C. (111°.02 F.) Wunderlich has seen several similar cases to that of Brodie, where the temperature reached 44° C. (111°.2 F.: and Dr. Woodman, the English translator of the work of Wunderlich, has recorded some fatal cases of Scarlet Fever, in which the temperature amounted to 115° F. (46°.1 C.) In two cases of Pneumonia, *which recovered*, under my treatment in the Charity Hospital, during the Winter of 1873, the temperature in the axilla reached 109°, and was probably about 112° F. in the internal organs. These cases were of interest as illustrating the fact, that this degree of temperature is not necessarily fatal. I have observed a temperature of 108°.5 F., and over in the axilla in a case of Yellow Fever, which terminated fatally shortly after this high degree of heat was reached. The delirium and restlessness of the patient, prevented the thermometer being well held in the axilla; the actual temperature was therefore somewhat above 108°, and probably reached from 110° to 113°, in the cavities of the heart. Dr. William Arnold has recorded a temperature of 110° F. in several fatal cases of Yellow Fever. In a case of Small-Pox attended with violent [illegible] and with expansion of one pupil and contraction of the other and which terminated fatally, and which occurred in my private practice during the month of April 1874 the temperature just before death as indicated by placing the bulb of the thermometer between the scrotum and the thigh, was 110°.5 F. The temperature of the internal organs in this case probably reached 113° F., and over.

Wunderlich* conceives, that the very high temperatures observed by himself and others and the equally extraordinary high temperatures, which are observed in tissue changes of the brain and upper part of the spinal cord, appear to shew, that there are moderating centres or apparatus in the brain, the paralysis of which is succeeded by a morbidly increased action of the processes which produce warmth. This observation is of practical importance, because it indicates that any considerable elevation of temperature in patients suffering from neuroses, when no particular reason can be assigned for the fever, which is developed, affords the worst possible prognosis.

It must be observed, however, that these observations of Wunderlich and others, relate only to the last stage of fatal tetanus.

In the case reported by Wunderlich in which the temperature reached 44°.9, a short time before death, the disease was of six days duration, and during the first five days e temperature was not above 37°.6 C. Thus in this case in which the temperature d remained at the normal standard during the first five days, in the last hours of life creased 7°.3 C., and fifty-five minutes after death, the temperature was still more evated, reaching 45°.5 C.; and in one hour and a half after this observation, the tem- rature descended to the point at which it stood at the moment of death, viz: 44°.9 .

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* On the Temperature in Diseases; a manual of Medical Thermometry, by Dr. C. A Wunderlich. Trans. New Syd. Soc., London 1871, pp. 204–425.

It has been shown by the experiments of Bernard and others, that in warm-blooded imals, a temperature ranging between 45° and 46° C., destroys the contractility of e muscles, thus mechanically as it were causing death, by the arrest of circulation and spiration. And Kühne has shown that the rigidity of the muscles is due in such ses to the coagulation of a special constituent. In a case of Tetanus observed at the ospital Pitié, by M. M. Peter,* the temperature remained normal (37°.3 C.) during e first five days, although the pulse was 120; on the morning of the sixth day diffi- lty of respiration and asphyxia, commenced and the temperature was elevated 3° 0°.3) in eight hours, and the pulse was only 100; during the next ten hours the mperature rose to near 1° C. (41° C.); in eleven hours and five minutes, at the oment of death when the patient was fully asphyxiated, the temperature was 42° C.

The sudden and rapid rise of temperature in Traumatic Tetanus, near the fatal termi- tion may be referred to the following causes:

1st. To the effects of the violent muscular contractions and agitations.

2d. To impeded respiration, causing, a less rapid cooling of the blood in the lungs the inspired air and by the loss of caloric in the expired air; and also causing the tention of carbonic acid, which deranges the normal chemical changes of the consti- ents of the blood, and excites abnormal actions in the muscular and nervous systems.

3d. The supervention of inflammation of some one or other of the internal organs, t more especially of the Lungs, as in *Pneumonia.*

4th. The translation or extension of the irritation of the gray matter, and especially at portion in connection with the motor nerves, into true inflammation, attended with ftening of the nervous structures.

5th. The extension of the irritation from those portions of the spinal cord especially onnected with the reflex functions, to those ganglionic centres within the brain and pinal cord which regulate the production of animal heat.

6th. The extension of the irritation, to the sympathetic or vaso-motor system of erves, either through the branches connected with the diseased structures, or through reflex action from the cerebro-spinal axis.

7th. The chemical and physical alteration of the blood, either by the perverted tions of the muscular and nervous systems, or by the generation within the living stem of some poison which acts as a ferment, or by such impeded elimination of the ements of chemical change, as leads to an alteration of the normal cycles of chemical mbinations and decompositions of the blood.

It might at first be supposed that the 7th and last hypothesis, was sustained by the ct that in certain cases of great elevation of temperature at the moment of death, the mperature of the body had slowly risen, a degree or the fraction of a degree, during a ort period; but this slight post-mortem rise, may be explained by the sudden arrest the respiratory process, and also to a great extent of the transpiration from the surface, us favoring an accumulation of heat within the body.

The rise of temperature, is most probably due to the causes stated under the third, urth, fifth and sixth hypotheses.

There are facts to sustain the fourth hypothesis, and in a subsequent portion of this vestigation, we will show by the results of post-mortem examinations, that the spinal ord, and even portions of the brain undergo structural alteration in many fatal cases of etanus; and we must regard the rise of temperature, as not characteristic of Tetanus a disease, (that is, for example, as certain oscillations of temperature, chraraterize alarial Fever, Yellow Fever and Small-Pox, and distinguish them from each other and from all other diseases,) but as indicating structural alterations in certain portions of the Cerebro-Spinal Nervous System or in the Lungs.

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* Gazette Hebdomadaire, 26 Janvier 1872, p. 54.

Such observations therefore, do not invalidate the proposition, which we have endeavored to maintain by an impartial examination of the testimony of the best writers, as well as by our own direct observations, *that Traumatic Tetanus is not necessarily accompanied by fever, that it is not related to the Febrile Diseases; and at the same time it differs in some important symptons from true inflammation.* The rapid rise of temperature observed in certain cases of Traumatic Tetanus, is evidently a phenomenon engrafted upon or added to the uncomplicated disease.

The weight of testimony, ancient and modern, sustains the view, that in uncomplicated Traumatic Tetanus, *fever*, (rapid pulse, rapid respiration, nervous and muscular prostration, and great elevation of temperature), is, as a general rule, absent; and when present, the increase of temperature cannot be referred to the special condition of the nervous system characterizing this disease.

The establishment of the proposition, that Traumatic Tetanus belongs neither to the Pyrexiæ, on the one hand, nor to the Phlegmasiæ, on the other, whilst under certain circumstances, both fever and inflammation may be engrafted upon it, has an important bearing upon the treatment of the disease.

PORTION OF THE NERVOUS SYSTEM INVOLVED IN TRAUMATIC TETANUS.

In the first case of Traumatic Tetanus, which we have regarded as typical of the uncomplicated disease, the Intellect remained clear and unaffected during the entire progress of the disease.

All observers, ancient, as well as modern, agree, that in Traumatic Tetanus, the intellect is unaffected, and that delirium, stupor or failure of the intellectual faculties, appear only in the general exhaustion and failure of the powers which in some cases precedes death. As is well known, a large proportion of fatal cases terminate suddenly during the violent spasms, from the sudden arrest of the respiration, whilst the intellect is unimpaired.

The peculiar expression of the countenance in Tetanus, characterized by the wrinkled forehead, contracted eye-brows, partially open eyes, dilated nostrils, partially open mouth, with the angles of the mouth drawn backwards and a little upwards, exposing the teeth, is manifestly dependent upon the involuntary contractions of the muscles of the face, and the expression of uneasiness and apprehension is not dependent upon mental disturbance.

Even in the remarkable case recorded by Professor E. Geddings in the Charleston Medical Journal, July, 1852, although the tetanic spasms appeared to be caused by the fracture and depression of the cranium, and was relieved by trephining, and elevation of the bone, the disease was unattended by cerebral disturbance.

Dr. Geddings acknowledges his indebtedness to Dr. H. R. Frost for the following notes of this case:

Case 17.—Traumatic Tetanus.

On the 17th August, 1851, Mr. M—— received a severe blow on the upper part of the right side of the forehead, with the end of an iron belaying pin, which was thrown at him, end foremost. The scalp was divided to a limited extent, and, as was subsequently discovered, the cranium fractured and driven down upon the dura-mater.

As no unpleasant symptoms, except those of an evanescent character, were manifested, the case was submitted to simple treatment, and the wound continued to heal kindly for several days, although it was found on introducing a probe, that the bone beneath was denuded.

On the 13th day after the injury, a feeling of uneasiness was experienced about the jaws, with a stiffness and inability to open the mouth. The symptoms of Traumatic Tetanus then declared, extended by slow steps to the muscles, tongue, neck, shoulders and back; to the diaphragm and abdominal muscles; and those of the hips and thighs. On the 17th day the jaws were so firmly closed, that he could not masticate, and the tongue felt so large and stiff at he could scarcely protrude it from the mouth. Sitting at the table he was seized with ain in the shoulder of one side, which seemed to stretch across to the other; pain at the orbiculus cordis next succeeded, which extended to the muscles of the small of the back nd legs. The muscles of the face, particularly about the eye-brows, were also much ffected.

All the above symptoms gradually increased in intensity, until the 12th of September, hirteen days from their inception. The mental faculties even at this late period, were not in he slightest degree disturbed, but the unfortunate patient was under the full influence of eneral opisthotonos. He complained of extreme weakness of the knees. The mouth was alf contracted; the jaws rigid, a sense of spasmodic contraction extended to the throat, ttended with a feeling of choking. There was also pain in the back, increased by the frequent tonic spasms; rigidity of the abdominal muscles; frequent spasmodic contractions of he muscles of the face, impressing upon the countenance that peculiar expression of distress o common in Tetanus. The skin was covered with a profuse perspiration, but there was either pain in the wound nor head.

The opiate treatment which had been previously instituted, with light diet, was still continued, but without manifesting the slightest control over the symptoms. The diet consisted of arrow-root, thin broth, etc.

During the afternoon the spasmodic contractions grew more violent and alarming. While reclining on a bench, he was seized with such violence as to be thrown upon the floor, from which he was unable to rise. The family greatly alarmed at this, sent for the attending physician, and on entering the room, the patient was found to be affected with violent spasmodic action of the whole body, manifested particularly by twitches of the face, rigidity of the muscles of the back, abdomen and the system generally, with tonic contractions of the muscles of the lower jaw; pain at the scorbiculus cordis; a profuse and general perspiration—the pulse being about one hundred, and irregular.

At this juncture, Prof. Frost, feeling that merely medical treatment could be no longer relied on, requested the aid of Professor Geddings in consultation. Professor Geddings found the patient very much in the condition described above. The tetanic spasms, which were general, and somewhat violent, were of frequent occurrence, being called into action by the slightest effort to move or speak. The mind was clear, however, and unusually calm; the pulse was hurried, feeble and irregular; the respiration embarrassed by the frequent recurrence of the spasms; and the whole surface cold, and covered with a profuse, clammy sweat. A wound of limited extent occupied the scalp, upon the upper part of the right side of the forehead, on probing which, Prof. Geddings found the bone beneath denuded, and implicated in a moderately stellated fracture, and depressed considerably below the natural level of the centre of the fracture, so that the sharp spicula encroached upon the dura mater, and compressed the corresponding portion of the brain.

After conferring upon the nature of the case, it was determined to perforate the cranium, and elevate the depressed bone. This, Professor Geddings proceeded to do immediately, in the following manner: An incision, with two branches, so as to form a small obtuse-angled flap, was made through the scalp down to the bone; the flap was turned up; the pericranium was detached to the requisite extent, and the edge of the undepressed portion of the bone cautiously perforated with a small trephine. This done, an elevator was passed through the aperture, and all the depressed portions of the bone were in succession elevated to their proper level, while the smaller detached fragments and spiculæ were removed. The flap was then adjusted, and secured by adhesive slips, and cold water dressings directed to be applied continuously.

Before the dressing was completed, the patient expressed himself greatly relieved. His countenance became more composed; the spasms were relaxed; the twitchings were much mitigated; the respiration became freer; the pulse, which was before frequent, small and irregular, now became more expanded; and instead of the cold and clammy surface, a general warmth diffused itself over the whole body. He was put to bed, an anodyne prescribed, and all visitors were excluded. Directed to be confined to water, tea, arrow-root, etc.

September 13th. In the morning Professor Frost visited the patient and found his aspect much improved. There was no longer any excitement, or general spasms; had rested quietly during the first part of the night and slept towards morning; pulse, 88; breathing, easy; jaws still contracted; but the spasms of the other portions of the body, much abated in violence; no pain of the head or in the wound; had taken nourishment and expressed himself much better.

Afternoon. No increase of spasmodic symptoms; general feeling improved; slight fever; pulse, 100.

14th. The tetanic spasms still gradually subsiding. The night was spent for the most part, in a state of sleepless disquietude, but some sleep was obtained towards morning. The pulse, 80; slight heat of skin; with trifling soreness and pain in the wound. The spasms occasionally recur in the muscles of the back, in those about the eyes and face, and his jaws can be only partially separated. He moves himself freely in bed; assists the nurse in adjusting his position, and feels so much better, that he craves for animal food; but his diet is still restricted.

Afternoon. Condition of the patient nearly the same; pulse, 80: spasmodic twitchings still take place down the back with rigidity of the jaw; wound partially united and healthy.

15th. Improvement progressive; spent a comfortable night; pulse 80, and regular; slight twitches still experienced in the back. Afternoon; no unfavorable changes, wound healing.

From this time, the patient continued to improve without interruption, and by the 19th day after the operation, the tetanic symptoms had entirely subsided.

In the preceding case, the tetanic spasms, were diminished in intensity, but not immediately and completely removed by the operation, and in fact the symptoms did not subside until the 19th day after the operation. The tetanic spasms were caused, either by the direct pressure of the fractured bone upon the brain, or by the transmission of the irritation to the medulla oblongata and spinal cord, through the nerves connected with the injured parts. If the first supposition be correct, the irritation was transmitted from the surface of the brain, through its structures, to the medulla oblongata and spinal cord, whilst at the same time, those portions of the brain which are supposed to be connected with the intellectual faculties appeared to remain unaffected.

Baron Larrey has recorded a case, in which tetanus supervening upon a lance wound in the right side of the forehead, was relieved by an operation, whilst the cerebral symptoms increased in severity, and the patient was destroyed by the inflammation of the brain. The following is the history of this interesting case, as detailed by Baron Larrey.

Case 18.—*Traumatic Tetanus.*

In a charge of Cavalry, Mr. Markeski was wounded by a lance on the right side of the forehead, the point of which glanced obliquely upwards and inwards, making a deep fissure in the os-frontis. One of the branches of the frontal nerve was divided by the cutting edge of the lance. Nine days passed without the appearance of any unpleasant symptom, and the wound was treated as usual; but on the night of the ninth day, tetanus came on, with convulsive motions of the lids of the eye, on the injured side and total loss of sight in this organ. He had slight delirium, acute local pain, locking of the jaws, and emprosthotonos was evidently about to take place. I first applied emollients, on the wounded part, and prescribed opiates and diaphoretic drinks; they procured no relief, and the disease advanced with such an alarming aspect, that I doubt not he must have died in twenty-four hours.

I probed the wound and soon ascertained its direction. The probe produced great pain, and I was induced to lay open the wound from one end to the other, with a bistoury and grooved director; with a single cut I divided the frontal muscle, nerves and vessels.

He was instantly relieved, and in less than twenty-four hours all the tetanic symptoms had disappeared. I now thought he might recover, but on the twenty-fifth day, symptoms of inflammation of the brain and its meninges with the characteristics of effusion appeared. I had been prepared to expect these consequences from the delirium before noticed, which is *never* a symptom of Tetanus. But at that time I had discovered only a small furrow in the external table of the os-frontis, made by the point of the lance. I now applied a large vesicatory over the scalp, and prescribed cooling drinks and anti-spasmodics. The disease still advanced, the fever increased, delirium followed, and he died on the 27th day.

On inspecting the cranium, we found the internal table of the frontal bone detached at the end of the fissure, and a considerable effusion of bloody purulent matter under the right anterior lobe of the brain, which was here also in a state of suppuration. When the first symptoms of compression appeared, after those of tetanus had subsided, I proposed the application of the trephine on this fissure, but was induced to omit it from the decision of several of my colleagues, who were of opinion that no effusion would follow so small a fissure. I regret that I did not pursue my first intention: *occasio præceps judicium difficili.* Memoirs of Military Surgery, Vol. II, p. 309.

It would appear in the preceding case, recorded by Baron Larrey, that the irritation causing Tetanus was transmitted to the medulla oblongata and spinal cord, through the injured nerves rather than through the cerebrum; for a clear division by the knife of the injured nerves relieved the tetanic spasms, but had no effect whatever upon the subsequent inflammation of the brain.

It has been up to a comparatively recent period generally admitted, that the hemispheres, or cerebral ganglia, are entirely destitute of both sensibility and excitability, throughout their whole extent; for the experiments of various physiologists have shown that both the white and gray substance may be wounded, lacerated, crushed, or galvanized in the living animal, without exciting any convulsive movement or any apparent sensation; on the other hand it appears to have been equally well established, that the cerebral hemispheres are the seat of the reasoning powers, or of the intellectual faculties; for when these ganglia are destroyed, the intellectual faculties are the only ones which are lost; in lesions of the cerebral substance, the earliest and most constant phenomenon is the impairment or loss of the mental powers; and the development of the mental faculties in man and animals, is in proportion to that of the cerebral hemispheres. The investigations of physiologists, and more especially of Longet, have established that the application of Caustic Liquids, of galvanic currents and mechanical irritation to the olfactory ganglia, the corpora striata, optic thalami, tubercula quadrigemina, and to the white and gray substance of the cerebrum and cerebellum, are without any manifest excitation and do not cause the slightest convulsive movements in the muscles below, or any painful sensation.

The anterior surface of the medulla oblongata, the tuber annulare, and the lower part of the crura cerebri; that is the lower and central parts of the brain, containing continuations of the anterior columns of the cord, are the only portions of the brain in which irritation is followed by convulsive movements; and in like manner, the upper part of the crura cerebri, the processus e cerebello ad testes, the restiform bodies, and the posterior surface of the medulla oblongata; that is those portions of the base of the brain, which contain prolongations of the posterior columns of the cord, are the only sensitive parts of the brain. The ganglionic centres of the brain which receive and originate the nervous impressions, are therefore regarded as being destitute of both excitability and sensibility; only those portions being capable of excitation by mechanical irritation, which conduct sensations and nervous impulses.

If therefore, these results of carefully conducted physiological experiments and extended pathological investigations, be accepted as established, then the conclusion appears to be unavoidable, that the cerebrum is not involved in Traumatic Tetanus.

The results of the experiments of Schiff, Hitzig, Fritsche and Ferrier, with the application of electrical currents to different portions of the brain, as well as the results of the experiments of MM. Fournie and Beaunis, in France, and Nothnagel, in Germany, upon the effects of destroying Small Parts of the Brain, have been fully unfolded in the preceding chapter, (Chap. 1st, Medical Memoirs;) and the objections to certain results of the experiments impartially considered.

If the results of these experiments, and especially those of Hitzig and Fritsche, and Ferrier, be confirmed by more extended and careful investigations, in which the electrical currents are *absolutely localized* so as to act *alone upon the parts subjected to experimental investigations*; and if it be clearly established that certain definite regions of the cerebral centres preside over the voluntary and combined movements of the muscles of the face, eyes and anterior and posterior extremities; it is clearly manifest that the proposition that in Traumatic Tetanus the cerebrum is unaffected, cannot be fully sustained.

That the cerebellum is probably involved to a certain extent in severe cases of Traumatic Tetanus, may be inferred from the results of the experiments of Flourens, confirmed by Hertwig, Budge, Longet and others, demonstrating that it regulates and coördinates all the voluntary movements of the frame; and from its extensive connections with the cerebro-spinal axis. In the experiments of Flourens, during the removal of the superficial layers of the cerebellum, there appeared only a slight feebleness and want of harmony in the movements, without any expression of pain; on reaching the middle layers an almost universal agitation was manifested, without any sign of convulsion, the animal performed rapid and ill-regulated movements, without losing the power of seeing or hearing; after the removal of the deepest layers, the animal lost completely the power of standing, walking or leaping, or flying, and when placed upon its back was unable to rise. The animal however did not remain quiet and motionless, as those deprived of the cerebral hemispheres do; but whilst retaining volition and sensation, evinced an incessant restlessness, and an inability to accomplish any regular or definite movement. Whilst the power of exciting movements remained, the power of cöordinating these movements into regular and combined actions was lost.

The remarkable revolutions performed by animals, when only one hemisphere of the cerebellum is injured or cut away, have been referred by some physiologists to the one-sided action of the muscles of the body, being no longer counterbalanced by those of the other side; whilst others have referred the cause, not to unbalanced voluntary movements, but to abnormal tonic contractions excited by the injury, the spine, especially its anterior portion being twisted, and the animal evidently trying to check the movements.

Whilst the cerebellum is connected only slightly with the hemispheres of the brain by the processus cerebelli ad testes, or more immediately with that part, which may be regarded as the centre of sensation, viz: with the optic thalami; on the other hand, it is brought into direct and extensive communication with each segment of the great nervous centre upon which all the movements and sensations of the body depend—it is connected with the medulla oblongata and spinal cord, through the restiform bodies; with the meso-cephale by the fibres of the pons, and thus with the anterior pyramids and corpora striata; and through the processus e cerebello ad testes with the optic thalami.

Baron Larrey has recorded an interesting case of wound of the cerebellum followed by Tetanus, which is as follows:

Case 19.—Traumatic Tetanus.

A light horseman, of very amorous disposition, received a sword-cut, which divided the skin and all the convex portion of the occipital bone, through to the dura mater. The right lobe of the cerebellum was seen through the opening of the dura mater, and the slightest pressure upon this organ caused giddiness, fainting and convulsive movements. The patient loses sight and hearing of the right side, experiences acute pain in the course of the dorsal spine, and tingling in the testes, which in fifteen days were reduced to the size of a bean. The patient died of tetanus with loss of the functions of sight, hearing and generation. On dissection there was great loss of substance at the occiput, the medulla oblongata and upper part of the spinal cord were of dull white, of firmer consistence, and reduced in size one-fourth. The nerves rising from those parts, were likewise wasted.

The stiffness and uneasiness about the muscles of the throat and neck accompanied with difficulty in opening the jaws, masticating and swallowing, and in rotating the head; the sunken watery immovable eyes, the suffused face, contracted brows, wrinkled forehead, expanded nostrils, with the distorted mouth, and sardonic grin; the forcible contraction of the pharynx and œsophagus, the fixed and elevated larynx, the harsh altered voice, the pain at the præcordium, *the forcing forwards of the shoulders*, the contracted chest, confined diaphragm, the rigid parietes of the abdomen, approaching the vertebral column, and forcibly pressing the viscera of the cavity, and the forced convulsive respiration; together with the violent tonic spasms of all the various muscles, and the contortions of the trunk and extremities in various directions, as one or all the opposing sets of extensor or flexor muscles were most powerfully contracted; were all so many manifestations of the exalted functional action of the cells of the gray matter of the cerebellum, medulla oblongata and spinal marrow.

In connection with this association of the tonic spasms, it is worthy of note, that in many cases of Tetanus, the first symptoms which attract the attention of the physician after the reception of the injury, is a complaint on the part of the patient, of stiffness and uneasiness about the joints of the jaws, the throat or neck, no matter what may be the location of the injury, whether in the head, or in the superior or inferior extremities. In such cases it would appear that the state of functional exaltation, first manifested tself in the region of the origin of the Trifacial (fifth pair) and of the Facial (seventh pair) of nerves; that is in the region of the junction of the peduncles of the cerebellum, with the medulla oblongata, and of the restiform and olivary bodies, and of the gray substance of the fourth ventricle, where the tension of the nervous force of the cerebellum and medulla oblongata appears to be greatest, as indicated by the convulsive muscular movements, spasm of the glottis, difficulty of deglutition, and irregular breathing following irritation of these portions of the medulla oblongata, and by the dependence of respiration upon this portion of the spinal axis, which as the concourse of all the nerves of sense, is also the medium for the transmission of sensitive impressions to all the regions of the head, trunk and extremities. And in such cases, it is probable that by the establishment of the state of super-functional activity in the cerebellum and medulla oblongata, the excitement propagates itself chiefly in a descending and peripheral direction, thus establishing a similar state of excitement in the gray matter of the spinal axis. The muscles connected with the spinal axis are thus excited to successive spasmodic contractions by sudden discharges of the nervous force generated in the cerebellum and medulla oblongata, after the manner of successive electrical discharges, through the different diastaltic arcs of the spinal system In this manner when the irritation commences in the medulla oblongata, we may explain the gradual invasion of the different ganglionic centres of the spinal axis, and the gradual generalization of the convulsive manifestations.

It would be an error however, to refer the manifestations of tetanic spasms, alone to this mode of origin in the superior portions of the spinal axis. In the first case, the irritation appeared to commence first in the nerves of the arm, and to affect first, those portions of the spinal cord, from which the brachial plexus is given off, and from this segment, the irritation appeared to be reflected to the medulla oblongata and cerebellum.

During the American civil war, cases which might be appropriately termed partial or localized tetanus, have been recorded, in which the irritation transmitted from the local injury, did not extend beyond the segments of the spinal cord, which received the nerves of the injured parts; and the spasms were limited to those muscles which received their nerves from the irritated segment of the spinal cord. In such cases, where the excitation of the nervous centres, was limited to a portion of the spinal cord, and did not involve seriously the medulla oblongata and cerebellum, the comparatively harmless disease yielded readily to treatment, As a general rule the favorable issue, was due to the limited extent of the irritation, rather than to the nature of the remedies, and this fact will account for the comparatively large number of cases of Tetanus reported cured upon the Field and Hospital Reports.

If this explanation of the mode of origin of a certain proportion of cases of Tetanus be correct, we are forcibly impressed with the necessity of an early and energetic use of such means as will tend most surely to arrest the propagation of the disease to the various segments of the spinal axis; for in proportion to the extension of the nervous excitement to the gray cells of the spinal axis, medulla oblongata and cerebellum, will be the certainty of a fatal termination.

We will in the next place, endeavor to extend this view of the phenomena of Tetanus, by the aid of the more recent discoveries of physiological science.

The view of the older anatomists, that the spinal cord was nothing more than a bundle of nerves, proceeding to, or from, the brain, and emerging at various parts of the vertebral canal, to be distributed to the destined regions, has been disproved by the results of anatomical explorations, as well as by the teachings of experimental physiology; and physiologists now regard the spinal axis, as devoted to the manifestations of excito-motor phenomena, and as cöordinating the movements of the trunk and extremities. Whilst it is true, that when the spinal cord is severed from the encephalon, it takes no share in the mental perception of sensations, and in voluntary actions; and that when united to the encephalon, its integrity is necessary to the perfection of the sensori-voluntary actions; it is on the other hand well established, that it is itself a ganglionic centre, capable of generating nervous force for the excitation of movements independently

[illegible] nerves, and that these actions of the
[illegible] stimulation, of the extremities of its
[illegible] irritation of its substance.
[illegible] regarded as a collection of ganglionic
[illegible] exciting independent action. The
[illegible] impulse passes upwards along the
[illegible] matter of the cord, and is from the
[illegible] of the interior root, until it finally
[illegible] function of the spinal cord, as an
[illegible] impression received from the skin,
[illegible] again to the muscles; and this
[illegible] by volition, conscious sensa-
[illegible]

[illegible] the cord is divisible into a
[illegible] to its proper segment of the
[illegible] other ganglionic masses of the
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[illegible] filaments pass from their origins
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[illegible] brain is conveyed to the
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[illegible] the muscles to

contract, or both results may take place at the same time, as the result of one and the same stimulus.

In a state of health, the controlling influence of the will, prevents many of the sensitive impressions from developing corresponding movements; but in the intense excitement, and in the super-charged state of the nerve cells of the gray matter of the cord, in Tetanus and in poisoning by strychnine, not only are all the parts of the surface capable of exciting nervous action, the slightest touch causing movements, not merely in the limb touched, but throughout the entire body; but the nervous apparatus, appears to discharge itself at intervals, independent of external stimuli, and entirely without control of the will.

According to this view, Tetanus essentially consists, not in an *inflammation* of the nerve cells and structures, nor of the membranes of the spinal axis, but in such a state of exalted functional activity in the nerve cells, as is attended with the constant generation of a larger supply of motor force, than is necessary for the maintenance of the normal healthy relations between the nerves and muscles. We will show in a subsequent portion of this inquiry, that this state of increased functional activity both in Traumatic Tetanus, and in that form of Tetanus induced artificially by the action of Strychnine, is accompanied by a congestion and increased supply of blood in the gray matter of the cord. This congestion of the cord accompanied by all the characteristic symptoms and manifestations of Tetanus, may continue throughout the disease without the establishment of true inflammatory action: on the other hand, in some cases during the progress of the disease, this state of congestion leads to the transmigration of the colored blood corpuscles and proliferation of the connective tissue and structural alterations of the nervous elements of the cord. We regard the latter condition as superadded to or engrafted upon the state of capillary congestion and exalted functional activity of the spinal cord, and not as essential to the manifestation of Tetanic phenomena.

The tetanic manifestations in this view express the state of exalted superfunctional activity of the cerebellum, medulla oblongata, and spinal cord; and it follows as a necessary consequence from that law of the animal economy, that for the exertion of force, we must have the chemical change of a corresponding amount of matter, (and as the amount of the force-generating elements of the gray matter of the nervous system chiefly affected in Tetanus is limited,) that the progressive exhaustion of the patient by the enormous expenditure of excito-motor, and muscular force, must be one of the most important causes of death in the disease. We cannot over-estimate the value of this indication in the treatment of Tetanus.

We will briefly examine in the next place, the mode in which the local irritation of a wound, may be reflected from the periphery upon the central ganglia of the spinal axis.

Our knowledge of the mode in which the nervous irritation originates in the injured parts, would be much advanced by correct and minute anatomical descriptions of the mode in which the nerves terminate in the organs, muscles and integuments, to which they are distributed, and in which they are supposed to terminate. The philosophical explanation of nervous action, must rest to a certain extent, upon the views of anatomists as to the ultimate arrangement and distribution of the nerve fibres. Our knowledge of the minute anatomy of many organs, is at present, by no means as perfect as we have every reason to believe that it will be in the future, by the aid of improved instruments and methods of microscopical research. Up to a comparatively recent period, the methods of preparation as well as the character of the optical instruments employed, were unsuited to the accurate determination of the mode of distribution of the nerve fibres, in such structures as the papillæ and tactile bodies of the skin, in the Pacinian bodies, in the retina and cochlea, and in the mucous membrane of the nose and mouth. Thus Geber in his efforts to determine the ultimate distribution of the cutaneous nerves, overcame the opacity of the cutaneous tissue of man and quadrupeds, by boiling portions of skin, and then steeping them in oil of turpentine, until they were rendered transparent; and Krause in similar investigations, treated the skin with nitric acid, and many of those violent modes of boiling and coagulating and [illegible], and coloring with strong chemical re-agents are still used in microscopical investigations of pathological as well as normal structures. In all future anatomical discussions of difficult questions, the method of preparation, as well as the power and character of the instruments employed, should be so fully and emphatically stated that the observation may be repeated and the drawings subjected to that critical scrutiny which the importance of the subject demands. We look with great expectations to the application of the art of photography to the correct representation of the minute anatomy of structures. Whilst it is true that no mere photograph can ever convey the knowledge acquired by patient and intelligent microscopical investigation of delicate structures viewed in thousands of varying attitudes and lights; at the same time, the photograph when perfect will tend to correct those regular diagrams so beautifully executed by some anatomical artists, and will also tend to expose the errors of those who are able to make the anatomical structures which they delineate correspond exactly to pre-existing theories.

It would be foreign to the present inquiry to present the results of an extended and critical examination into the views of various distinguished observers, as Valentin, Kölliker, Kühne, Krause, Waldeyer, Engelmann, Letzerich, MM. Cohnheim, Vulpian, Rouget, Langerhans and others, as to the mode of distribution and termination of nerves in voluntary muscles.

It is now generally admitted by competent observers that the ultimate nerve tubules consist of four distinct parts, viz.: the sheath of Schwann, or tubular membrane; the medullary matter, or white substance of Schwann; the axis cylinder; the elements of the axis cylinder, which may be one or many fibrils.

Numerous conjectures have been formed as to the ultimate structure of the axis cylinder which fills the tube formed by the white medullary tissue around it; by some histologists it has been described as composed of minute longitudinal fibres, while others regard it as made up of laminae placed one upon another. According to Schultze, the ultimate anatomical nerve element is the primitive fibril, of which a number, great or small, is needed to make an axis cylinder, so that the primitive fibril is the essential nerve element around which, or around groups of which, may be the medullary sheath and the sheath of Schwann.

Frommann also, in a recently [illegible] (Journ. de l'Anat. et Phys., 18[illegible], p. 269), by exposing the nerves to a peculiar treatment with nitrate of silver, reached the conclusion that the axis cylinder is composed of disks superimposed and isolated by a substance differing from them in composition. Dr. S. Weir Mitchell, of Philadelphia (Injuries of Nerves and their Consequences, p. 17), has verified these observations on the sciatic nerve of the frog with preparations made by Dr. Keen, and obtained the same result; and he concludes that it is difficult, considering the regularity of the structure thus brought out, to reach any other conclusion than that the axis is probably less simple in construction than has been believed. According to the same observer, if we admit with Schultze ([illegible] Anat., Berl., August 1868), and Stricker, that this substance also possesses [illegible] striae, the likeness to the anatomical disposition of the muscle would be remarkable—a likeness for which there may also be some physiological foundation.

A recent observer, Professor H. D. Schmidt, M. D., of New Orleans (Monthly Microscopical Journal, 1874, pp. [illegible]), in his observations "On the Constitution of the Dark [illegible] Nerve Fibre," states that according to the results of his investigations:

"The axis [illegible] about [illegible] in diameter, which are arranged [illegible] this substance, and thus form a bundle of [illegible]. Each axis [illegible] therefore, according to its thickness, composed of a number of these [illegible] are enclosed within a distinct [illegible]. The difference between the view of Max Schultze and my own, consists [illegible] nature of the fibrils and the interfibrillous substance, and also in the [illegible] a sheath." * *

> The granular fibrillous structure of the axis cylinder is very distinctly recognized on those of the finer nerve fibres of the spinal marrow or the brain, consisting of two or even only one fibril, and on which no sheath is any more to be seen. The contours of these, namely, do not appear as straight lines, but as a row of small convexities, each of which is produced by a projecting granule. * * On the finest ramifications of some processes of the ganglionic bodies of the cortical substance of the brain, or in the termination of fine nerve fibres in its nervous network, the granular nature is unmistakable.
>
> The fibrils of the axis cylinder extend through the processes of a ganglionic body over its surface. A considerable number of them connect the processes with each other, i. e. a part of the fibrils of one process arising at the ganglionic body, pass over its surface and take part in the formation of other processes. The course of the rest I must leave untouched for the present. * * In examining, therefore, the surface of a ganglionic body illuminated obliquely with an amplification of 700 diameters, it will appear to be composed of minute groups of granules. This is especially the case in specimens prepared with a solution of chromic acid; in fresh ganglionic bodies, however, these groups of granules appear almost as so many minute polygonal bodies with a dark point in the centre. As such I had also regarded them until a year ago, when by a careful re-examination of the subject, I found that the ganglionic bodies, as well as the processes proceeding from them, were composed of the same granular fibrils as the smaller axis cylinders. * *
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> For a further evidence of the granular-fibrillous bodies and their processes, I may be permitted to point to the observations of *Frommann* and *Grandry*, made on nerve fibres and ganglionic bodies, previously treated with a weak solution of nitrate of silver; the axis cylinders and processes here showed, as is known, for a certain time a distinct transverse striation, until, after a continued action of the light, the specimens assumed a brownish-black color. It is very obvious in this instance, that the fine transverse striæ, represented the intermediate substance, connecting the granules, and in which the metallic deposit first took place, and that accordingly this substance must possess in a higher degree the property of decomposing the metallic salt, than the granules, and must also have a different chemical composition. After a continued exposure to light, this property also manifests itself in the granules and causes the coloring of the whole specimen.
>
> In comparing the granular-fibrillous structure of the axis cylinders and processes, as above described, with that of the striated muscular fibres, we can hardly overlook the analogy existing between the two, particularly during the earlier stages of embryonic life. In a tolerably fresh human embryo about 17 mm. in length, I found these muscular fibres still in their first stage of development, and those furtherest advanced, only represented by narrow bundles, consisting of very distinct granular fibrils. The intermediate substance, connecting the granules is here, like the axis cylinders, only sparsely represented, in consequence of which the latter almost touch each other. Not until the intermediate substance becomes more developed in volume, do the characteristic transverse striæ of these muscular fibres appear, while the granules become more separated from each other. In the embryo of three months, the striation is already quite distinctly seen; at the same time, the granules appear in the form of minute quadrangles. If we take further into consideration that the electro-motor behavior of the striated muscular fibres in a state of activity, are similar to those observed in the nerves, it might be presumed that perhaps, between the terminations of the motor-nerve fibres and these muscular fibres, a more intimate relationship exists than is now supposed. And further, if we consider those so-called *sarcous elements of Bowmann* as the elementary bodies or agents through which the contraction of the muscular fibre is effected, we might, judging from the above mentioned analogy of structure, also look upon those granules, composing the fibrils of the axis cylinders, as the true *nervous elements*, i. e. those anatomical elements through which the propagation or transmission of the nervous force takes place.

It appears to be generally admitted that the tubule may be finally traced into the cells of the ganglia composing the spinal medulla and the brain, and that before joining these cells it loses its sheath and white covering, becoming thus reduced to the single element of the axis cylinder, which has hence been regarded as the essential portion of the ultimate tubule. the exterior portions serving merely for protection or for insulation.

A similar loss of the external medulla and sheath, and a like thinning of the axis cylinder, is usually observable in the peripheral extremities of nerve tubules; but great diversity of opinion exists as to the manner in which they terminate in muscle and sensitive surfaces. The *sensitive* nerves may be traced for the most part to a plexiform series of loops which underlie the skin and other sentient surfaces, and which according to Beale, and some others, constitute the true peripheral termination of many sensitive nerves, which, returning again to their central cell connections, form, as it were, a neural circuit.

If we accept as true, the recent observations of Professor Lionel S. Beale, of London, (*An Anatomical Controversy; the Distribution of Nerves to Voluntary, etc. Archives of Medicine*, 1865,) upon the distribution of nerves to voluntary muscle, we will be able to form a conception of the mode of origin of Traumatic Tetanus, which will correspond with the well-established laws previously examined with reference to the structural relations and modes of action of the various elements of the cerebro-spinal system.

Dr. Beale claims that he has demonstrated that the nerve fibres passing to a muscle, divide at length into a vast number of exceedingly fine, pale granular fibres, which ramify upon the external surface of the sarcolemma, connected with which fibres at certain intervals, are oval nuclei, and that these fine fibres, after an extensive and in many cases very circuitous course, are continuous with other fibres to form dark bordered fibres, which at length pass toward the nervous centre, either in the same bundle as the dark bordered fibres passing toward the muscle, or in other bundles. It therefore follows, that of the dark-bordered nerve fibres distributed to a muscle, some pass from the nervous centre towards the muscle, some from the muscle towards the nervous centre, and that the nerve fibres *do not end* in the muscle at all. The results of these researches considered in connection with those arrived at from the investigation of various kinds of nerve centres, justify the inference that the fundamental arrangement of a nervous apparatus, is a complete and continuous circuit. These observations of Dr. Beale, the importance of which cannot be over-estimated, as they involve the typical arrangement of various nervous instruments, show, therefore, that so far from there being distinct ends to nerves, that in all cases, complete circuits exist; and that in these circuits are included *central nerve cells*, and *peripheral nerve cells*, generally termed nuclei, which are connected by intervening fibres. The course of any given fibre may be extremely complicated, and there may be many minor circuits connected with the greater one, but in all cases there is a circuit—a nerve never ends.

These views differ materially from those of Kühne, who holds that the nerves terminate in ends beneath ths sarcolemma, and are in fact, continuous with rows of nuclei which lie among the contractile tissue; and from those of Kölliker, who agrees with Kühne, as to the termination of nerves by ends, and with Beale, as to the fine nerve fibres being upon or external to the sarcolemma, instead of penetrating through this membrane, and coming in contact with the contractile tissue. MM. Krause, Waldeyer, Engelmann, Letzerich, MM. Conheim and Vulpian, all admit the existence of a terminal plate, and its entire independence of any nervous network. According to M. Rouget, the terminal division of the axis cylinder of the motor nerve fibre, constitutes by anastimosis and fusion, a terminal expansion of finely granular substance identical with that of the terminal filaments of the corpuscles of Pacini, of the ultimate lamina or electrical plates of fishes, etc., and in immediate contact with the contractile substance of the primitive bundle; this nervous expansion is traversed in every direction by minute canals, establishing a connection between the numerous nuclei of the plate, and communicating probably on the one hand, with the space intermediate between the sarcolemma and the contractile fibrillæ, and on the other hand, with the interstices between the matrix of the nervous tube and the medullary layer.

The importance of the results of the investigations of Dr. Beale, are seen in a clear light, when we attempt to apply them to the explanation of certain nervous diseases. Thus if we attempt to apply these anatomical facts to the explanation of Traumatic Tetanus, we observe:

1st. The nerves in their ultimate branches and ramifications, form a net-work of great complexity and extent.

2d. Within this extended network, and connected by both afferent and efferent nerves, with the central ganglia, are potential elements, true nerve-force generating cells.

3d. A local injury or irritation is capable of producing a state of super-functional activity in the nerve cells of the periphery of the sensitive and motor nerves. As these cells exist in immense numbers even in comparatively small portions of structure, and as they are within the same closed circuit with the nerve cells of the gray matter of the cerebro-spinal axis, a state of superfunctional activity or irritation might be readily transmitted from the periphery to the central ganglia. Thus a local nervous exaltation of nervous function in the peripheral nuclei, may be capable of propagating itself, first to the nervous cells included in its own peculiar circuit, and from these latter, through the channels of intercommunication, to the various segments of the spinal axis. The irritation thus excited may also be communicated to the special system of nerves which accompany the neural-blood-vessels: for Sappey has shown that contrary to the common opinion, the vascularity of the nerve sheaths is greater than that of ligaments, tendons, or aponeuroses, and approaches in this respect the spinal or cerebral pia mater. The arteries are exceedingly numerous, and lie chiefly between the walls of the fibrous partitions in the spaces formed by their juxtaposition; and the veins, like the arteries, form an intricate plexus. Sappey has described as *nervi nervorum*, the minute neural fibres which follow the path of the vessels and are distributed to the sheath of the nerves. The fact that the neural arteries and nerves, are not met with in the sheath of the *ultimate nerve fibre*, would indicate that the subsequent congestion of the nervous trunks in traumatic tetanus, was due to an extension of the irritation from the peripheral network of the ultimate nerve fibres. Without doubt the nervi nervorum, or nerves of the blood-vessels of the nerves, form a portion of the general system of vaso-motor nerves, and through this channel as well as directly through the irritated nerves of the injured part, the excitement may in tetanus be conveyed to the vaso-motor nerves of the spinal axis, and lead to increased supply of blood to the central ganglionic cells, and increased excito-motor action.

It is but right, that we should add, that in the preceding observations, and in our application of the results of the microscopical investigations of Dr. Beale, to the explanation of the mode of origin of Tetanus, we do not at all claim for Dr. Beale, the discovery of the formation of extensive networks in the peripheral fibres of the nerves, and the rëunion of the ultimate fibres composing the networks, into nerves which return to the central ganglionic masses.

Thus, Valentin, Burdach and other observers, represent the nervous fibres distributed to the skin of the frog, as dividing into numerous small fibres, and forming a close anastimosing net-work, which does not end in the tissue, but after coursing for a longer or shorter way, returns, sooner or later, to the larger branches of the nerves. Schwann observed that the nerves in the web or fin of the tadpole's tail, and in the mesentery of the amphibia, divide into numerous fine fibres destitute of the white substance, without any dark outline, and presenting little enlargements, from whence delicate fibres spread out in various directions, and connect themselves in the form of a delicate and extensive net-work. The subsequent observations of Quain, confirmed by those of Schwann, also showed that the smallest nerve fibres presented here and there along their course elongated corpuscles, like cell nuclei. The researches of Rudolph Wagner upon the distribution of the electrical organs of fish, in like manner establish the doctrine, that the peripheral nerve fibres divide and sub-divide, and rëunite, and are distributed in a plexiform manner, like the ramifications of the capillaries. Her Bilharz has shown that the small nerve which supplies the electrical organ of the electrical Silurus, (Malapterus), keeps continually dividing, until it finally resolves itself into an enormously great number of ramifications, which spread themselves out upon the electrical organ, thus allowing of the sudden diffusion of the nervous influence over the whole extent of the electrical plates. The investigations of Meissner and Billroth have shown that the sub-mucous layer of the intestines is, as Willis had long before declared it to be, a nervous tunic. The afferent nerves of the intestine, after having divided, finally break up into extensive net-works, presenting, at certain points, nodules, having the appearance of ganglia, from which the nerve fibres spread out into interlacements, like the net-work of capillaries. This arrangement not only enables us to understand the nature of peristatic action, but it also offers a ground-work for the explanation of tetanic spasms, and convulsive affections, arising from irritating substances in the alimentary canal, similar to that afforded by the distribution of nerve fibres to voluntary muscles.

We are enabled by such facts to understand how a local irritation may excite superfunctional activity in the adjacent nervous centres, and there, in virtue of their communications with other nerve centres, may extend the influence over larger tracts of the intestines, and the excitation may also extend to the central sympathetic ganglia, and from thence be reflected upon the spinal axis.

Such physiological and pathological applications as we have made of these anatomical facts, which tend to the establishment of the peripheral division and expansion of the nerves into extensive net-works, or of their direct connection with special apparatus, as the retina of the eye, and the tactile bodies, do not appear to have suggested themselves to the observers to whose labors we have referred. We have thus endeavored to refer the phenomena of Tetanus to anatomical and physiological relations and laws.

CONDITION OF THE CIRCULATION AND RESPIRATION IN TRAUMATIC TETANUS.

In the First Case, the respiration was disturbed during the paroxysms, but between the paroxysms it was performed as usual; thus affording a striking contrast to the respiration of fever and inflammation in the acute stages.

In the first case, the pulse, and the action of the heart were disturbed during the spasms, but gradually resumed their natural actions during the intermissions.

When the heart was uninfluenced by the nervous and muscular disturbances, it manifested the actions of health, rather than those of inflammation or fever. After a careful examination of the relations of the perturbations in the heart's action, to the tetanic spasms, it was established that they succeeded but never preceded the spasms, thus indicating that either an influence was transmitted from the medulla oblongata, through the pneumogastric nerves to the ganglia and nerves of the heart, causing spasms in its muscular fibres, similar to those excited in the muscles under the control of volition, by the peculiar state and force of the motor nerves, or else the sudden contractions of the muscles, and the suspension of respiration, not only suddenly forced much blood upon the heart, but also forced blood improperly oxygenated upon the heart, and thus deranged its actions, by distending its cavities with venous blood. The first supposition appears to be the most reasonable, because the phenomenon was too regular, and the irregular action of the heart lasted after the cessation of the spasms, and gradually disappeared, to be again suddenly renewed upon the supervention of a new spasm.

This intermittent action of the heart, during the tetanic spasms, appeared to be worthy of more than a casual observation and bare record.

The intermittent action of the heart appeared to be immediately associated with the violent disturbances of the cerebro-spinal nervous system, and resembled the disturbance produced in the action of this organ, by the transmission of electrical currents through certain portions of the cerebro-spinal and sympathetic systems.

The heart as is well-known is supplied with nerves from the sympathetic and par-vagum; the sympathetic branches come from the superior middle and inferior cervical ganglia, and frequently also from the first dorsal ganglion; the branches from the par-vagum, come directly from the trunk of the nerve, and indirectly from the recurrent and inferior laryngeal: and these nerves, after forming different anastimoses, and plexuses with each other of the same side, converge at the upper and back part of the arch of the aorta, where they form a free anastimosis with those of the opposite side, and then pass on to the heart. The motor and sensitive filaments received by the sympathetic from the oculo-motorius nerve, inferior and superior maxillary, opthalmic and lingual branches of the fifth pair, facial nerve, and from the spinal nerves, establish a relationship between the heart and cerebro-spinal system. The Pneumogastric (par-vagum) nerve, by its origin from the lateral portion of the medulla oblongata, in the groove between the olivary and restiform bodies, and by the branches which it receives from the spinal accessory, facial, sub-lingual, and anterior branches of the first and second cervicals, in like manner establishes a relationship between the heart, and the cerebro-spinal system, and more especially, as in the case also of the sympathetic, with the medulla oblongata. We are thus enabled to understand that it is possible to transmit a nervous impulse from the cerebro-spinal system, and more especially from the medulla oblongata to the heart.

The following experiments establish a close similarity between the perturbations of the heart's action, during the violent spasms of Tetanus, and the action of powerful electrical discharges upon the medulla oblongata and Pneumogastric nerves.

E. H. and E. Weber, discovered the singular fact, that when the par-vagum or the medulla oblongata is excited by a powerful electro-magnetic current, in a living animal, the movements of the heart are suddenly stopped According to G. Valentin,* when shocks of the electro-magnetic machine, are made to act upon the trunk of the vagus nerve, in a newly killed and still highly sensitive animal, the pulsation of the heart is instantly brought to a stand still. If the electrical action be not continued too long, the state of diastole, will last during the whole time of the experiment; but if it be continued, the heart after some time recommences beating. The *roots* of the vagus or accessory nerve lead to what are essentially the same results when stimulated in a like manner. On the other hand, when the experiment is successfully repeated, on the trunk and branches of the sympathetic, the pulsations of the heart are always accelerated. The same antagonism is often repeated by the roots of the vagus, and those of the sympathetic, or the corresponding spinal nerves. Hence, there is some peculiar difference, which the intervening ganglia can neither originally produce, nor subsequently remove; at least, not as regards the powerful stimulus of repeated electrical shocks. The arrest of the heart's action by repeated irritation of the roots of the vagus, is a true diastole, having no resemblance whatever to a tonic systolic spasm; and indeed the tension of the arterial blood is considerably diminished, although it finally remains at a considerable height. On laying bare the nervous centre of a living frog, and applying electrical irritation to the whole medulla oblongata, the heart is always arrested in the diastole. The rudimentary cerebellum, and corpora quadrigemina, sometimes give rise to the same result; while the optic lobes only do so under circumstances of special central excitement. The corpora callosum, and the deeper lateral portions of the cerebral hemispheres, as well as the crura-cerebri and corpora quadrigemina, frequently evince a most unquestionable action on the heart of the recently killed animal. When the heart of a newly killed frog has ceased to beat, it is just as capable of being excited to new contractions, from the spinal cord as from the sympathetic. In the application of a rapid succession of electrical shocks, the same contrast is repeated between the medulla oblongata, and the upper part of the spinal cord, as between the vagus, and sympathetic; the former arresting, and the latter quickening the action of the heart.

When a defined portion of the vagus has been stimulated for some time continuously, the heart again begins to pulsate; when a portion of the nerve above this point is now stimulated, no effect is produced; when, on the other hand, the stimulus is applied to a portion further down, nearer the heart, a cessation of its movements is again produced. The circumstance that the heart, after the stimulus has been applied to the pneumogastric for some time, again commences to beat, is attributed, by Weber, to the part of the nerve becoming exhausted, or losing its restraining influence, when the heart being thus freed again, begins to pulsate. Budge, however, attributes the cessation of the movements of the heart, produced by the application of galvanic stimulus to the pneumogastric, not to any restraining power exercised by that nerve, but rather to a temporary exhaustion produced by the strength of the stimulus. In support of this view, he states that, although the movements of the iris chiefly depend upon the oculo-motor nerve, yet Weber found, when the wires of the magneto-electric rotation apparatus were applied to this nerve within the cranium, that the pupil became dilated, remaining so for a considerable time after the stimulus had been withdrawn, and then again slowly contracting. The effects thus produced upon the iris are, according to him, analogous to those produced upon the heart by the application of the galvanic stimulus to the pneumogastric. Moreover, the nerves which are sent to the heart of the frog, do not present the arrangement which Weber has described. No other filaments than those which pass from the vagus, are distributed to the heart of this animal, at least no others have been demonstrated. The vagus nerve becomes united with the sympathetic in the ganglion, which is situated about one line from the roots of the pneumogastric; and from this ganglion which contains fibres of the vagus and sympathetic, springs, amongst other branches, a slender filament, which is destined for the heart. This runs downwards on the inner aspect of the lungs, and passes along the veins to the auricle and ventricle, the former receiving the greater number of the nerve fibres. The branch in question contains fibres derived from the pneumogastric.

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* Text book of Physiology, § 1754, 1787, 1800, 2003, 2005.

Again, such a restraining power must hold an opposite relation to the moving power in the normal condition; the moving power would, therefore, express itself only in part, according as the other is in a latent state, or in a state of activity, and consequently section of the vagus nerve ought, did it exert the restraining power in question, to be followed by an acceleration in the movements of the organ, which is not the case. Budge, therefore, seems to regard the fibres which are sent to the heart in the frog, by the pneumogastric, as possessed of motor and sensory properties. Schiff also found that when the heart's action has been made to cease, by application of the wires to the groove between the auricles and ventricles, this effect cannot be counteracted by applying them to the bulbus arteriosus. The phenomenon of the cessation of the heart's action, produced by the application of the galvanic stimulus to the pneumogastric, he explains, by supposing that its fibres are in a state of activity during the systole of the corresponding part of the heart, but quickly became exhausted, thus allowing the diastole to take place: thereafter, their activity being again renewed, a second systole results. When, therefore, strong galvanic stimuli are applied to the nerve, the state of exhaustion continues longer, and in the same proportion the diastole, or cessation of the heart's action, is also longer.*

On the other hand, Dr. Brown-Séquard† has observed that section of the pneumogastric nerves, is followed by paralysis and dilatation of the blood-vessels of the heart, and that the excitation of these nerves, (by galvanism or otherwise), produces contraction of the blood-vessels. He explains by this contraction the stoppage of the heart's action, when the medulla oblongata, or the pneumogastric nerves are galvanized, as in Weber's experiments. The heart, according to Dr. Brown-Séquard's theory, owing its contractions to an excitation produced by some element of the blood existing in the small arteries and veins. Now, if we suppose that galvanization of the par-vagum produces a complete constriction of the capillaries of the heart, it is easy to understand why the heart is stopped; it is because the excitation cannot take place, on account of the expulsion of the blood from the capillaries. If it be objected to this view, that the effect of galvanization is immediate, and that the arteries and veins possessing only fibro-muscular cells cannot contract suddenly, it may be answered that it is a fact, that although there are only organic or non-striated muscular fibres in their vessels, they do contract immediately when the pneumogastric nerves are galvanized: and Brown-Séquard has discovered that the capillaries of the face and ear are constricted when the sympathetic nerve is galvanized in the cervical region. It is known that the nerves of the heart are distributed much more to its blood-vessels than to its muscular tissue. By this supposition, the stopping of the heart's movements is placed among the well known facts, that an excitation of a motor nerve produces a contraction of the muscles to which it is distributed; and, therefore, we are not obliged to admit that an excitation of a nerve is able to produce directly either a contraction or cessation of existing contractions.

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* Wagner's Handwörterbuch der Physiologie, band iii; Astherbung, ii, p. 45; band iii, p. 415; Cyclopædia of Anatomy and Physiology, Vol. v, pp. 460, 461.

† Experimental Researches Applied to Physiology and Pathology, pp. 77–79; Principles of Human Physiology, by William B. Carpenter, M. D., etc, Phila., 1856; pp. 243, 244.

According to this view, then, when the medulla oblongata is excited by the electrical current, the stopping of the heart is not produced by a loss of irritability of this organ; and the practical inference follows, that in cases of syncope occurring in Tetanus, and in other diseased states, from the influence of the nervous force, or of an emotion upon the medulla oblongata, it might be possible to excite the beatings of the heart, either by compression of the chest, or by an application of galvanism.

If the view of Dr. Brown-Séquard be correct, we ought to find that the heart will beat, if, during the stoppage produced by galvanization of the medulla oblongata, we substitute for the missing excitation, (in consequence of the expulsion of blood from the artereies and veins), another stimulus. This has been done, and it is found that a mechanical or galvanic excitation re-establishes the movements of the heart. Another fact has been discovered by Dr. Brown-Séquard, which he considers very important. When a galvanic current is applied to the heart, or to the pneumogastric nerves in the neighborhood of this organ, it is known that its pulsations are not stopped by it, and that sometimes, on the contrary, they appear to be quicker and stronger. Now, if the theory of Dr. Brown-Séquard be right, how is this to be explained? In this case, the vessels of the heart are contracted, as when the medulla oblongata is galvanized; but the muscular fibres are directly excited by the current which produces the same effects as the missing excitant expelled from the vessels. The truth of this explanation appears to be proved by the fact discovered by Dr. Brown-Séquard, that if the galvanic current is interrupted, the heart ceases at once to beat, and resumes its action if the current is applied again. Another very important fact is, that if an energetic galvanic excitation is applied to the medulla oblongata of a frog, for ten, fifteen or twenty minutes, (sometimes five minutes are sufficient), the heart, which had stopped, at once resumes its action.

This fact, discovered by the brothers Weber, and unexplained by them, is thus explained by Dr. Brown-Séquard.

The vessels of the heart, as well as the vessels of any other part of the body, cannot remain contracted a very long while, their contractility diminishing gradually during their contraction. Dr. Brown Séquard has seen the same thing when he applied galvanism to the cervical sympathetic nerve; the vessels of the ear remained contracted five or six minutes, or a little more, and then gradually became dilated, although the excitation of the nerve was continued.

Whilst therefore it is true that the ordinary movements of the heart are but little dependent upon nervous influence of any kind, as may be shown by the continuance of its action after destruction of the entire cerebro-spinal nervous system and even after its complete separation from the chief centres of the sympathetic system, and removal entirely out of the body; on the other hand, the results of the experiments with the application of the magneto-electric current to the medulla oblongata, superior portion of the spinal cord, pneumogastric and sympathetic, the depressing effects of sudden emotions, of shock, of crushing suddenly the spinal marrow, or of a limb, the fatal effects of sudden and violent blows upon the epigastrium, and the effects of the tetanic spasms in arresting or accelerating its motions, all establish the fact, that the action of this organ may be influenced by disturbances and abnormal actions in the cerebro-spinal and sympathetic systems.

In traumatic tetanus, its actions may not only be arrested in some cases, but in many others they are vastly accelerated, without any corresponding elevations of temperature, as in the rapid action of this organ in fever. And it is a question worthy of investigation, how far the fatal termination in Traumatic Tetanus, may be due to disturbances in the action of the heart, induced by influences transmitted from the medulla oblongata and spinal cord through the pneumogastric and sympathetic.

Dr. C. H. Parry, in his work on Tetanus and Hydrophobia, attached great importance to the state of the heart, which he imagines becomes exhausted, and first loses its vital powers. (*Cases of Tetanus and* Rabies Contagiosa, p. 81).

Mr. Benjamin Travers held that the ultimate tendency of the disease, is to travel into the region of organic life, and affect the heart and other viscera with its spasm. Mr. Travers considered Tetanus as essentially a disease of function, which destroyed by exhaustion, if not by sudden translation of the spasm to the heart. (*Further inquiry concerning Constitutional Irritation, and the Pathology of the Nervous System.* pp. 332, 333).

Dr. Currie remarks, that the patient when the case terminates fatally, probably dies at last from spasmodic affection extending to the heart. (Medical Reports, vol. i, p. 118). Dr. Currie in common with other observers, refers the fatal issue in a certain proportion of cases, also to arrest of respiration.

Case 20: Traumatic Tetanus.

Mr. Howship published a case (Med. and Phys. Jour. xxii, p. 185, London 1809.) where the patient in describing his suffering, is reported to have said, that he "felt that his heart was at times ready to break with the distress of its pain." The heart when examined eleven hours after death, the body being still warm, was found so much reduced in size, as not to occupy a fourth part of the cavity of the pericardium, and appeared to be very much and unnaturally shortened from the basis to the apex. Upon pressing the muscular ventricles, they gave the resistance of a very firm and even horny substance, rather than of mere fleshy cavities. The auricles as well as the ventricles, were greatly contracted, and felt unnaturally firm. The sides of the left ventricle were found in the closest contact, so much so, that when a section of the heart was made, the exact situation of the cavity was not immediately to be perceived. About half an ounce of blood still remained in the right ventricle. The auricle on the right side, contained about an ounce of blood, that on the left, a much less proportion. The heart was removed from the body, and upon being examined a few hours afterwards, it was found to have become completely relaxed, was much larger and softer, as well as very flaccid, having entirely lost that very peculiar and remarkable state of tone which it possessed at the time of its being first inspected. Mr. Howship describes no other morbid appearance, and concludes, "that it was on every side clear, that the muscular structure of the heart had in this case become at length subject to the same affection which, during the earlier stages of the disease, was confined principally to those parts of the body subservient to voluntary motion."

Whilst we have no anatomical data, by which to determine the relative frequency of such a condition of the heart, as that described by Mr. Howship, it is however established that it is by no means uniformly present in death from tetanus, and may also be present when death is caused by other diseases. Thus Dr. John Reid, after describing the morbid appearances in a case of Tetanus, observes, that

> "The difference of the ganglionic system from the spinal was well marked, by the influence of the disease not extending in a similar manner to the muscular organs of both systems. This is marked by the muscular part of the heart and intestines being paler than natural, while the muscular organs belonging to the spinal system are remarkably florid and red." *On the Nature and Treatment of Tetanus and Hydrophobia, etc.* Dublin, 1817.

Dr. James Copland states that in two acute traumatic cases, which he examined after death,

> "The heart did not present any appearance different from that observed in cases of sudden or rapid death from other causes. Both these cases terminated in asphyxia." *Dictionary of Practical Medicine.* New York 1857, vol. iii, p. 1103.

Dr. Curling says:

> "That in other diseases, the heart when examined within a few hours after death, may often

seem exceedingly rigid and closely contracted, in consequence of irritability remaining in the muscular fibre after life is extinct." *Treatise on Tetanus*, Philad., p. 14.

It has also been supposed that the unstriped muscular tissue of the arteries may be affected with spasm in tetanus. Thus in a case of amputation on account of Tetanus supervening upon a lacerated wound, performed by Mr. Liston, the vessels contracted so completely that there was no hæmorrhage, and ligatures on the mouths of the divided vessels became unnecessary (Ed., Med. and Surg. Jour. xxi. p. 292). Whilst the contractile power of the arteries was evinced to a remarkable extent, this appears to be an isolated case in the history of Tetanus, and Mr. Curling affirms that he has witnessed it in almost an equal degree, in an amputation performed upon a patient free from Tetanus.

That the direct and decided influence transmitted to the heart during the spasms, in some cases of Tetanus, is of a powerful nature, and resembles the effects of a current of electricity passing through the medulla oblongata and roots of the pneumogastric nerves, is rendered still farther manifest by the effects of great muscular exertions and spasms in increasing the frequency of the pulsations of this organ, even when it has been isolated from the spinal cord.

The normal effect of the violent spasms in Tetanus is to increase the action of the heart, both in frequency and force; it is therefore difficult to determine how far the increased action of the heart in a certain proportion of cases, may be due to the transmission of an impulse through the sympathetic nervous system, which, as has been shown, acts in a manner the reverse of that of the electrical and nervous impulses transmitted through the pneumogastric.

Dr. Parry has attempted to establish grounds for forming a probable conclusion as to the final result of death or recovery, in this disease, by attending to the state of the pulse. Thus, he says:

> "If in an adult the pulse, by the fourth or fifth day, does not reach one hundred, or perhaps one hundred and ten beats in a minute, I believe the patient almost always recovers. If on the other hand, the pulse on the fourth day is one hundred and twenty or more in a minute, few instances will, I apprehend, be found in which he will not die."

It is well established however, that the danger in Tetanus, is neither proportional to the intensity of the spasms, nor to the rapidity of the action of the heart, but is dependent rather upon the particular class of muscles affected. Thus, if the muscles of the throat and chest, the muscles of respiration, be early and decidedly involved, the great danger is asphyxia, from the sudden arrest of respiration as well as from the injurious and depressing effects of the impeded respiration.

Dr. Parry's rule cannot with our present knowledge be adopted as a guide for accurate prognosis, not only because the action of the heart, may be greatly influenced by the remedies employed, but also because the rule is not sustained by the testimony of other writers, as Sir James Macgregor, Dr. Morrison, Dr. Hennen, Mr. Curling and others.

In many fatal cases, the pulse has varied but little from the normal standard of health, whilst in other cases in which the pulse exceeded one hundred and ten beats, the patients recovered. In all the cases witnessed by Mr. Curling, the action of the heart, as well as the respiratory movements were in some degree accelerated; and during the paroxysms there was generally a further increase, of about ten or twelve pulsations in the minute, whilst towards the close of the disease, the pulse became feeble, irregular and sometimes intermittent. The circulation in tetanus does not therefore present the marked and uniform acceleration and slight oscillations, characteristic of certain diseases, as Yellow Fever, Malarial Fever and Small-Pox.

FUNCTION OF THE SKIN ACTIVELY PERFORMED; TONGUE BUT SLIGHTLY FURRED: BOWELS OBSTINATELY CONSTIPATED, DURING THE ACTIVE STAGES OF TRAUMATIC TETANUS.

As a general rule, in Traumatic Tetanus, the function of the skin is actively performed, and the patients are frequently bathed in perspiration.

It does not appear to be necessary to refer the profuse perspiration of some cases of Tetanus, to deranged nervous action, either immediately, or as the sole cause. This increased activity in function of the skin, appeared to be the result in great measure of the increased muscular actions. Without doubt also, the pressure of the muscles upon the internal organs and vessels, and upon their own veins and capillaries must impart to the fluids a peripheric impulse. As far as our knowledge extends, the cutaneous secretion in Tetanus, is not "*critical*," and its amount and character, furnishes no grounds for a favorable or unfavorable prognosis. In those cases which recover, we have no reason to suppose that any poison is either wholly or in part, eliminated by the skin in this disease.

In the FIRST CASE, the tongue was but slightly furred; and at no stage of the disease did it present the dry furred appearance so common in many fevers and inflammations.

The bowels were obstinately constipated. This constipation preceded the violent spasms, and was not therefore the result of muscular pressure. This state of the bowels was most probably connected with disturbance in the nervous system. Closure of the anus by the spasmodic action of the sphincter ani, would not account for the constipation, because it *preceded* the stage of rigid contraction of the muscles; neither will the violent pressure of the muscles upon the alimentary canal, in conjunction with the great transpiration from the skin, account for this symptom, for a similar reason, that these were *subsequent* to the establishment of constipation.

Without doubt, the pressure of the abdominal muscles, the profuse perspiration, and the effects of the opiates administered, all tended to render the bowels torpid; but the fact which we wish to establish, is that this state preceded these conditions, and could not therefore be more than aggravated by them. Whether the constipation was due to spasm, or persistent contraction of the unstriped muscular fibres of the bowels, thus preventing all peristaltic motions, or to derangement in the secretory and excretory apparatus of the mucus membrane of the alimentary canal, or to both causes combined, cannot in the present state of our knowledge be accurately decided; it is however well-known, that in other diseases of the brain and spinal cord, besides Tetanus, the bowels are torpid.

Whether we incline to the opinion of Bichat and draw a broad line of demarcation, between the cerebro-spinal nervous system, as presiding over the functions of animal life, and the sympathetic, as presiding over the involuntary movements, and over the processes of secretion and excretion, the functions of vegetation and reproduction, and regard the sympathetic ganglia as entirely independent of the cerebro-spinal; or to the view of the older physiologists, which has been revived and ably advocated in recent times, that they are not independent systems of nerves, but that the sympathetic is dependent upon the cerebro-spinal for its properties and forces, and must therefore be regarded as one of its systems of nerves: we are in either case justified by such well established facts, as the disturbance and perversion of nutrition by mechanical injuries and pathological alterations of nerves, the mutual actions of the digestive, urinary and generative organs, the variations under nervous excitation of the circulation and secretions in the various abdominal organs, the production of convulsions by the presence of undigested matters in the alimentary canal, nausea attending pregnancy, temporary amaurosis, double vision and even hemiplegia following derangement of digestion, diarrhoea and inflammation of various internal organs following exposure to cold and wet, disturbances in the action of the heart and in the digestive functions by moral and mental emotions, dilatation of the pupil under the impression of terror, sudden injection of blood into the capillaries of the face as an effect of mental emotion, and other similar facts, in holding that reflex nervous actions may take place, through the sympathetic system from one organ to another, or from the organs through this system to the cerebro-spinal, and through this portion of the nervous system to the voluntary muscles and sensitive surfaces; and also that they may take place from the exterior sensitive surfaces, through the cerebro-spinal system to the sympathetic, and through it again by reflexion, excite the involuntary muscles and various abdominal organs.

These well established physiological and pathological facts, and these mutual relations and interchange of impressions, between the sympathetic and cerebro-spinal systems, may as is well known, be readily explained by the anatomical connections of the two systems. The sympathetic receives fibres from the cerebro-spinal system, through its communication with all the spinal, and nearly all the cranial nerves, and in turn appears not only to send its own fibres into the spinal axis but even its peculiar ganglionic cells are now said to exist in the gray matter of the spinal cord. According to M. Jacubowitsch, structures which are analogous to the ordinary ganglionic cells of the sympathetic, occur in the middle of the spinal marrow, and in several parts which are regarded as belonging to the brain. This observer has distinguished three kinds or forms of cells, in the gray matter of the cord, which he affirms lie generally in separate groups, and which he distinguishes as motor, sensitive and sympathetic. It follows from the observations of Jacubowitsch, that the whole cerebro-spinal nervous system (the spinal marrow, the elongated marrow, the quadrigeminal bodies, the brain, and the cerebellum,) and the entire ganglionic system, consist in a general way of four kinds of nervous elements; the cellules of motion, the cellules of sensibility, the ganglionic cellules, and the cylinders of the axis of all these cells. According to this view the ganglionic nervous system does not constitute a separate system but belongs essentially to the cerebro-spinal system. The different cells are the roots of the nerves of the same nature as themselves. All the nerves issuing from the brain, the cerebellum, the spinal marrow, and medulla oblongata, are, according to their origin, of a mixed nature, and they contain filaments originating in different cellules, in greater or less proportion, so that there are found in them nervous filaments of motion and sensation. The nerves of the great sympathetic have their roots in the ganglion cells. Large multipolar cells are accumulated in those parts of the cord, which are subservient to motor actions, as the anterior and lateral parts of the anterior horns, they are met with in the cerebellum, corpora quadrigemina, and in the anterior cornua and gray matter of the medulla spinalis, but not in the oblongata; they have been traced into efferent nerves of the anterior root, and give origin to motor nerves, and are therefore designated as motor cells. The small many rayed fusiform cells, found in the direction of the posterior horns and in the medulla spinalis, oblongata, cerebellum and corpora quadrigemina, and in all parts of the cerebral hemisphere, are connected with the fibres which run into the posterior root, and are therefore thought to be subservient to the functions of sensation. Those cells which Jacubowitsch has called sympathetic, are larger than the sensitive cells, have fewer branches, and are distinguished by a greater roundness of shape. The bipolar or sympathetic cells are of an oval form, and have two axis cylinders. They are found in the medulla spinalis and oblongata, in the cerebellum and corpora quadrigemina, but not in the cerebrum. In the medulla spinalis, they are principally found around the central canal. They are very abundant in the medulla oblongata, constituting its greatest portion. Whilst the special position and connections of the sympathetic cells, have not as yet been so clearly defined, still the view appears to be reasonable, which considers them as the origin of the sympathetic roots which run from the spinal marrow to the main trunk of the sympathetic.

According to Professor Jacubowitsch, the axis cylinders proceeding from the multipolar cells form the nerves of motion; and it is for this reason that they are called cells of motion; the axis cylinders of the *fusiform* cells, form the nerves of sensation, and these cells are termed the cells of sensation; the axis cylinders of the *bipolar* cells, are in relation with the great sympathetic, and the cells are termed ganglionary cells.

The same and different species of cells communicate with each other as follows:

(*a.*) The cells of *motion* communicate from one side to the other of the anterior commissure, or rather this commissure is formed by the intercoming in every direction of the axis cylinders which proceed from those cells. Those of the same side also communicate by the axis cylinders which proceed directly from one to the other.

(*b.*) The cells of *sensation* communicate from one side to the other, by the posterior commissure, or rather they constitute that commissure; but they remain parallel to each other and do not intercross. Those of the same side communicate directly.

(*c.*) The axis-cylinders of the *ganglionic* cells pass by either the anterior or posterior commissure; and thus communicate from one side to the other, like both the other species. Communications also take place between those of the same side.

(*d.*) Communications moreover take place between the different varieties of cells; but Jacubowitsch has only met with them in the cerebellum and in the corpora quadrigemina, in which the three varieties of cells occur. The different species of cells are not equally abundant in all the regions of the medulla spinalis. Thus in the cervical and lumbar regions, the cells of motion predominate, while in the dorsal region those of sensation are not numerous. The medulla oblongata, according to the views of Jacubowitsch, is purely and simply a prolongation of the medulla spinalis; a prolongation entirely formed of cells of sensation, containing in their centre, a nucleus of ganglionic cells.

The cerebellum, according to this observer, is formed of four elements, viz: First, of the elements constituting the white substance, and which are prolongations, by means of the peduncles of the pyramidal bodies which furnish the elements of the cells of motion, of the restiform bodies, which furnish the elements of sensation, and of the ganglionary element, which enters with each of the other two. Second. Besides these three elements, the periphery, or coritical substance of the cerebellum, is formed of characteristic pyriform cells peculiar to this organ. From these pyriform cells prolongations are sent to the surface of the organ, forming a layer, termed by Jacubowitsch, Conche en baguettes.

The *corpora quadrigemina*, formed by the prolongations of the peduncles of the cerebellum, by the restiform bodies and by the horse-shoe-shaped commissure, contain the three varieties of cells, which they derive from their various origins. But this is the last point where these three varieties are found together. Above this, in the hemispheres, as already stated, the cells of sensation, of which the corpus callosum forms the commissure, are alone met with.

With the exception of the optic, the olfactory, the auditory, the vagus, glosso-pharyngeal, and the hypoglossal nerves, which only consist of cells of sensation and ganglionic cells, all the nerves are formed of the three varieties of cells, with this difference among them, that the nerves of motion contain especially the cells of motion, and so on.

It results from these facts:

1st. The three entirely distinct functions of the nervous system, motility, sensibility and organic action, are not only exercised by the different orders of nerves, but morever, these orders of nerves take their origin in different central anatomical elements.

2d. The *medulla spinalis*, whence arise the general nerves, contains equally and naturally the three orders of elements, but the brain, the organ of the intellect, contains but the elements of sensibility, (which abound according to the intelligence of the animal), and the nerve of the special senses are also made up of the same element, with which is united in small proportion, only the ganglionary element.

3d. In affections of the nervous system, in which the most minute ordinary examination can detect no material lesion, such lesion may, nevertheless be considerable, since one or more of these orders of elements may become greatly altered in their form, or even undergo destruction. (Moniteur des Hópitaux, Sept. 8, 1857. Am. Jour. Med. Sci., N. S., 1858; Vol. 35, p. 237.

The preceding results of the investigations of M. Jacubowitsch, if fully confirmed by competent observers, will not only explain the mode in which irritation of structures, as the mucus membrane of the intestinal canal, supplied entirely with sympathetic fibres, may be propagated to the spinal axis, and give rise to tetanus, but they also cast light upon the singular phenomenon, noticed two thousand years ago, and which appears to be characteristic of the disease in the traumatic form, in all climates and ages, viz: That the intellect is unaffected in Traumatic Tetanus.

By the light of these physiological and anatomical investigations, we are led to infer, that in Traumatic Tetanus, the motor and ganglionic cells are chiefly, if not entirely involved; and the former to a greater extent than the latter.

The intimate relations of the two great systems of nerves, is still farther shown by the fact that the pneumogastric nerve, which aids in forming three of the sympathetic plexuses, the pharyngeal, cardiac, and solar, gradually predominates over and supplies the place of the sympathetic in the lower animals, and this gradual substitution of the former for the latter goes on in the descending series, until in the Cephalopodous mollusks the sympathetic almost entirely disappears, and the pneumogastric occupies its place and performs its office.

The intimate mingling of the elements of the two systems would seem to indicate that the difference in the functions of individual nerves cannot be referred so much to differences of structure, as to the peculiarities of the structures with which they are connected; that is, the functions of the ganglionic central organs, and the nature, structure and functions of the organ in which the nerves terminate, as well as the arrangement of the periphery or distal apparatus of the nerves afford the ground for the determination of their special functions.

As, therefore, the peculiar ganglionic cells of the sympathetic exist in the spinal marrow, and as it receives both motor and sensitive fibres from the spinal axis, it cannot therefore be considered as an isolated self-acting system in a highly organized animal; but, whilst admitting this proposition, it would be erroneous to affirm that it derives its powers entirely from the cerebro-spinal system, and is dependent upon it for a constant renewal of its force.

By these anatomical and physiological principles we are enabled to understand, not only the mode in which a nervous influence may be transmitted from the cerebro-spinal system to the sympathetic, and through it to the unstriped muscular fibre of the alimentary canal, thus causing obstinate constipation, by the arrest of peristaltic action, but also the mode in which tetanic spasms may be induced by the irritation of undigested matters, and by the presence of worms in the alimentary canal. When tetanic spasms are induced by irritating matters in the alimentary canal, the irritation extends from the mucus surface of the alimentary canal, to the surrounding net-work of nerves in the sub-mucus layer, and from thence it is reflected to the sympathetic ganglia, and finally to the spinal ganglionic cells.

The irritation is repeated as it were, in the spinal cord, and from this centre impulses are sent out to the motor nerves and muscles.

These changes without doubt take place slowly in many cases, and hence it is not necessary to assume, as some have done, that the obstinate constipation of Traumatic Tetanus stands in the relation of a cause to the spasms.

We are also led to this practical conclusion: That whilst, in the treatment of Traumatic Tetanus, we should hope to derive some benefit from the free evacuation of the bowels, at the same time, when the disease is dependent upon an injury of the nerves, the constipation is dependent upon the excited state of the spinal ganglia, and does not stand in the relation of a cause in the production of the disease, and will be soonest overcome by those remedies which have a direct effect in controlling the exalted action of the ganglionic cells of the spinal axis.

We will close this portion of the inquiry with a single observation,—in those diseases, as *Typhoid Fever*, where there is great loss of excitability and power in the cerebro-spinal and sympathetic nervous systems, we find a reverse condition to that which exists in Tetanus; instead of an exaltation of the reflex actions of the cord attended with obstinate constipation, there is general insensibility to impressions, mental dullness, depression of nervous and muscular power, and loss of tone in the unstriped muscular fibres, and tympanites, and profuse diarrhœa.

CHANGES OF THE URINE DURING THE VARIOUS STAGES OF TRAUMATIC TETANUS.

The changes in the amount and character of the urine were important, in furnishing data for the establishment of the relations of the disease to fever and inflammation. The following observations refer to the First Case of Traumatic Tetanus.

a. The amount of water excreted during the active stages was greatly diminished from the normal standard. Thus the following amounts were excreted during the twenty-four hours preceding the date: July 8th, grains [illegible]; 9th, grs. [illegible]. 10th, grs. 10,962; 11th, grs. [illegible]; 12th, grs. [illegible]; average amount for July 13th and 14th, grains [illegible]; 15th, grs. [illegible]; 17th, grs. [illegible].

As soon as the remedies employed had made a decided impression on the nervous system, as manifested by marked diminution of the force and frequency of the spasm, and consequent increased ability to take solid and fluid food, the watery element of the urine increased greatly. Thus the following amounts of water were excreted during convalescence: average amount of water excreted each day, July 22d and 23d, grains [illegible]; 24th, grs. [illegible]; average amount July 25th and 26th, grs. 16,204; average amount July 27th and 28th, grs. [illegible]; July 31st, grs. [illegible].

This concentration of the urine during the active stages of the tetanic spasms, appeared to have been due chiefly to two causes: 1st, to the inability of the patient to drink fluid in any very large quantity; 2d, to the loss of fluid from the skin, the amount of which we have before attempted to estimate. When the jaws were relaxed, the usual amount of fluids were drunk, the spasms ceased to cause the loss of fluids from the surface, and then the usual amount of water was separated from the blood by the kidneys.

We have thus dwelt upon the concentration of the urine in Tetanus, because this phenomenon is one that is common to fevers and acute inflammations. Thus, I have almost invariably witnessed, and have frequently recorded, a diminution of the watery element of the urine in Intermittent, Remittent, Congestive, Yellow and Typhoid Fevers, in Small Pox, Pyaemia and Erysipelas, and also in Pneumonia and Pleuritis.

It is evident that the cause of the diminution of the watery element of the urine in Traumatic Tetanus is dependent upon well defined causes, which will not account for a similar diminution in fevers and inflammation.

b. Urea. The urea was diminished during the active stages of the disease.

In determining the value of this proposition, it should be borne in mind, that during the severe spasms the patient was able to take only fluid nourishment, and that in much smaller quantities than in health, so that the patient was in a state of partial starvation.

The following amounts of urea were excreted during the active stages, in 24 hours: July 8th, grains [illegible]; July 9th, grains [illegible]; 10th, grains [illegible]. 11th, grains [illegible]; 12th, grains [illegible]; average amount 13th and 14th, grains [illegible]; 15th, grains 386; 16th, grains [illegible].

The average amount of urea excreted daily from July 8th to July 16th, inclusive, 9 days, was grains [illegible], whilst the average amount of urea excreted daily during convalescence from July 17th to July 31st, 15 days, was only grains 342.46, notwithstanding that during this time more food was taken than during the active stages of the disease. In this latter period it is important to note, that just after the cessation of the severe spasms the urea sank to a low figure and continued thus for several days, and then gradually rose to the standard of health, being on the 31st of July, 543 grains.

The estimates by various observers as to the average amount of urea excreted during twenty-four hours by adult men, vary within wide limits; but the variations may, however, be reconciled by referring them to the differences of methods of analysis, and to the different circumstances and conditions of rest, exercise and food.

Lehmann* estimated the amount of urea excreted by healthy adults at from 25

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* Lehmann's and [illegible] Physiological Chemistry.

270 grains in twenty-four hours. Golding Bird* places the average amount excreted y healthy men during twenty-four hours, at 270 grains. The following are the results educed by M. Lecanu from a series of 120 analyses:

	Maximum Grains.	Mean Grains.	Minimum Grains.
dult Men	510.36	433.13	357.5
dult Women	437.15	295.15	153.2
ld Men (84 to 86 years)	295.15	125,22	61.0
hildren of Eight Years	264.20	207.99	161.7
hildren of Four Years	81.83	69.55	75.2

According to Lehmann,† a healthy man excretes during twenty-four hours, from 340 600 grains of urea. This physiologist obtained the following results from experi- ents upon himself:

Urea Excreted in Twenty-four Hours.

ixed Diet	Grains,	501.76
nimal Diet	..	821.37
egetable Diet	..	347.10
on-Nitrogenous Diet	..	337.90

In the first set of experiments Prof. Lehmann adopted an ordinary mixed diet, and ok no more solid or liquid aliment than was needed to appease hunger and thirst, and bstained from fermented drinks. Every two hours he took exercise in the open air, ut avoided immoderate exertion of every kind; the result given upon the first line repre- ents the average amount of urea passed, under these circumstances, for fifteen days. n the second set of experiments, Professor Lehmann lived for twelve days on an ex- lusively animal diet, which, during the last six, consisted solely of eggs; he took hirty-two eggs daily; which contained 2929 grains of dried albumen, and 2431 grains f fatty matter, or about 3532 grains of carbon, and 465.5 grains of nitrogen. From the able it is seen that the urea increased from 501.76 grains to 821.37 grains, and con- ained more than five-sixths of the whole amount of nitrogen ingested. In the third et, the experimenter lived upon a vegetable diet, and during this period the average aily amount of urea fell to 347.10 grains. In the fourth set, the diet consisted en- irely of pure farinaceous and oleagenous substances, so that the azotized matter of the rine (urea) must have been solely the result of the disintegration of the tissues; and is seen to have undergone a rapid and marked diminution, for this diet was used only wo days; the health of Professor Lehmann was so seriously affected, that he was nable to continue this diet longer.

Dr. John C. Draper found the average quantity of urea excreted during twenty-four ours to be 408 grains. Bischoff[1] places the average for adult men at 540 grains.

The average daily amount of urea excreted by adult males, between twenty and orty years of age, has been given at the following figures by the different observers: arkes,[2] 371.5 grains; Benke,[3] 378.2; Scherer,[4] 416.8–460.4; Moos,[5] 444.6; Böcker, 44.9; Sehneller,[6] 458.2; Neubauer,[7] 511.2; Kaupp, 535.1; J. Vogel,[8] 540.0; V.

* Urinary Deposits; Journal De Pharmacie, 1839, t. xxv, p. 681.

‡ Physiological Chemistry, (Cavendish Soc. Ed.) Vol. ii, pp. 450–452.

[1] Harnstoff als Mass der Stoffwechsels, 1853.

[2] Composition of Urine.

[3] Die Weikung des Nord—See Bades, 1855, p. 30.

[4] Wurzburg Verhandlungen, Band iii, p. 184.

[5] Henle's Zeits, für rat.'Med., Band vii, p. 291.

[6] Valentin's Report on Phys. Canstatts Jahresb, fur 1855, p. 108.

[7] Archiv. des Vereins fur Wiss. Heilk, Band iii, p. 63.

[8] Neubauer's Anleitung, 2d Ed 1855.

[illegible],[9] 541.3; Beigel, 551.0; Mosler,[10] 558.9; Rummel,[11] 563.6–605.2; Kerner,[12] [illegible]; Ranke,[13] 656.0; Hammond,[14] 670.6; Gentle, 512.4; Warnecke,[15] 520; [illegible],[16] 575.8 grains. Dr. Edmond A. Parkes,[17] in his work on "*The Composition of the Urine in Health and Disease, and under the Action of Remedies*," gives as the mean result of numerous analyses of the urine of adult males, between twenty and forty years of age, the mean in the analyses being generally drawn from more than six, and often ten to twenty days, at 512.4 grains during twenty-four hours. Dr. Thudichum in his work on the *Pathology of the Urine*, affirms that numerous experiments have shown that a healthy man, who lives well, discharges from 30 to 40 grammes (463 to 617 grains) of urea in twenty-four hours. The discrepancies in these results are referable chiefly to differences of chemical processes, and in the diet and modes of living of the subjects of the experiments. Thus, the process employed by Becquerel (the separation of the urea as a nitrate), yields lower results than the volumetric method of Liebig, which was employed by most of the observers, whose results have just been presented, and which method was also employed by myself in the analyses of the urine recorded under the head of the *First Case of Traumatic Tetanus*. In addition to this, the subjects of Becquerel's experiments were Frenchmen, who, from their size and diet, appear to yield a less amount of urea than Englishmen, and probably also than Germans. Professor Lehmann, according to his statement of the amount of food consumed during his investigations, evidently excreted more urea than usual; and the average founded upon his experiments would be somewhat higher than the average with Americans. If we adopt the standard of Dr. Thudichüm, which is full high for Americans, and too high for Confederate soldiers during the American civil war, 1861–1865, when they were compelled to dispense with all the luxuries and superfluities of diet, it is evident that notwithstanding the state of almost absolute starvation to which this patient was subjected during the active stages of Tetanus, the urea, so far from being diminished, maintained very nearly the standard of healthy men actively employed and supplied with full diet.

If we compare the amounts of urine, excreted during the same paroxysms, with the amounts excreted by Prof. Lehmann, in a vegetable diet (347 grains) and on a non-nitrogenous diet, 232 grains, it is evident that it was greatly increased.

In the experiments of Dr. William Hammond, we have still more valuable data for determining definitely the increase or decrease of the urea. At the time that these experiments on the nutritive value and physiological effects of albumen, starch and gum were performed, Dr. Hammond was 28½ years of age, 6 feet 2 inches in height; 38½ inches around the most prominent parts of the chest; weight ranging from 215 to 230 pounds; temperament sanguine-nervous; habits temperate, using neither alcoholic liquors nor tobacco. As to his exercise, Dr. Hammond states: "I rose from bed at 6½ A. M. and retired at 10½ P. M.; eight hours of the twenty-four were accordingly passed in inactivity, the remaining sixteen was apportioned in the following manner: eight were occupied in conducting the necessary analyses, and in other work in the laboratory; four were given to chemical and philosophical studies; and four were taken up with the duties of his profession, physical exercises, recreation, etc. The exercise was quite limited, consisting of walking about one thousand yards per day."*

[9] Scherer's Report on Phys. Chem., Canstatt's Jahresb. 1855, p. 206.

[10] Archiv des Vereins, Band iii, p. 431.

[11] Würzburg. Verhandlungen, Band v.

[12] Archiv des Vereins, Band iii, p. 627.

[13] Composition of the Urine, by Parkes; London, 1860, p. 8.

[14] American Journal Medical Sciences, April, 1859.

[15] Dublin Medical Press, July, 1859.

[16] Dublin Journal, Aug., 1859.

[17] Composition of Urine, pp. 7, 8.

* Experimental Researches relative to the value and Physiological Effects of Albumen, Starch and Gum, when singly and exclusively used as food, etc. By William A. Hammond, M. D., etc. Trans. Am. Med. Ass. 1857.

Upon a diet exclusively of starch, amount of urea excreted 1st day, grains 421; 2d day, 369; 3d day, 225; 4th day, 204; 5th day, 160; 6th day, 175; 7th day, 157; 8th day, 185; 9th day, 132: 10th day, 121 grains. Daily mean for the ten days 215 grains.

Upon a diet exclusively of gum, amount of urea excreted 1st day, grains 330; 2d 301; 3d 282; 4th 275; giving a daily mean of 279 grains.

The effects of this insufficient diet upon the excretion of urine, in this observer, is placed in a clear light, when compared with the results of the examination of his urine in health, under ordinary diet, and under a diet exclusively of albumen. Upon a full, generous diet, the average daily amount of urea, excreted by Dr. Hammond, was 694 grains; and upon a diet exclusively of albumen 715 grains. Dr. Hammond upon a previous occasion determined the amount of urea excreted during exercise and rest; during moderate exercise 682 grains of urea were excreted during 24 hours; increased exercise 664 grains; and during no exercise or rest, 487 grains.

If now we consider that Dr. Hammond weighed from 70 to 85 pounds more than this patient, and farther, that during the active stages of the disease the patient suffering with Tetanus (Case No. 1) did not consume as much food as Dr. Hammond did, when upon the starch diet: and still farther, that during his experiments, Dr. Hammond was actively exerting his muscular and nervous energies, whilst the Tetanic patient was at rest, as far as his voluntary motions were concerned; we must come to the conclusion, that the amount of urea was increased, and in fact was more than double that which would have been excreted, if the patient had been in a similar state of starvation, without the tetanic spasms, and in the enjoyment of his usual health.

This increased amount of urea was clearly referable to the incessant muscular and nervous exertions, during the tetanic spasms—for as soon as they were relaxed, the urea diminished in amount, notwithstanding that large amounts of food were consumed.

The rapid diminution of the urea below the standard of health, after the disappearance of the spasms, appeared to be due, chiefly to the cessation of the muscular and nervous actions; or rather to that chemical change of matter by which the muscular and nervous forces are generated. After the cessation of the spasms, the patient remained perfectly quiescent, unable even for a length of time to stand alone; during this period of rest, although food was liberally supplied, it was most probably employed in the economy, to replace those portions of the muscular and nervous tissues, which had been consumed in the development of the increased forces; and as the forces during this period were feeble, so also the changes necessary to the generation of the forces, were correspondingly feeble, and the amount of matter altered correspondingly small.

It should be carefully noted, however, that the urea was not increased during the active stages of the violent Tetanic spasms, to that extent which is common in Fevers, and acute Inflammations.

In the active stages of Typhoid Fever and Pneumonia, I have found that it is by no means uncommon for the urea to be doubled and even trebled in amount, and to average from 772 to 1235 grains during the twenty-four hours; and that, too, whilst the patients were taking, as in this case of Tetanus, little or no food. In yellow fever, when the kidneys perform their normal functions, and when there is no abdominal alteration of these organs, and diminution of their excretion, the urea is in like manner greatly increased; and in those cases in which the lesions of the kidney are so great as to lead to the suppression of the urinary excretion, the urea is in like manner formed in large amount, and accumulates in the blood, and induces symptoms of uremic poisoning.

Whilst, then, in the case of Traumatic Tetanus, (No. 1), the urea was increased above the standard of starvation, it was not increased to that extent which is common in fevers and inflammations.

This fact sustains fully the conclusion previously announced, that uncomplicated Tetanus should be classed neither with the Pyrexiæ nor with the Phlegmasiæ.

(c.) *Uric Acid:* The uric acid was diminished during the active stages, and was increased during convalescence.

This constitutent of the urine, therefore, presented the reverse change to that of the urea. This result corresponds to that obtained by some physiologists during active exercise of the muscles, and during rest. Thus, Dr. Hammond found, that whilst during active exercise, only 8.7 grains of uric acid were excreted during twenty-four hours, during moderate exercise, 13.7 grains, and during perfect rest, 24.8 grains were excreted during a similar length of time. Lehmann and other observers have obtained similar results. The change from partial starvation to full diet, during convalescence, without doubt, as has been conclusively shown by the experiments of Lehmann, Hammond and others, caused an increase in the amount of uric acid: it appears, however, that the state of rest, after the paroxysms, had as much to do with the increase of the uric acid, as the increase of food. If the relations supposed to exist between uric acid and urea in their origin in the animal economy, be assumed as established, it might have been inferred that the reverse condition should have been manifested, that is, that the disturbance of respiration during the paroxysms, should have caused the increase of the uric acid: it should be remarked, however, that the disturbances of respiration during the tetanic spasms were not such as to cut off or materially lessen the supply of oxygen, for the disturbances were temporary and partial, and even during the most powerful spasms, sufficient oxygen was received into the lungs.

(*d*). *Free Acid.* If we receive as true the statements of Vogel, that the free acid, during health, may range from 30 to 61 grains during the twenty-four hours, it is evident that in this case, if due allowance be made for the effects of the hot weather, and for the fact that the determination of the free acid was frequently necessarily delayed for hours after the urine had been voided, it is evident that no special change in the amount of this constitutent can be discovered. And even if such change had been noticed, it would be difficult to determine its true significance, for it is even a matter of doubt with some physiologists, whether the free acid be due to the reaction of phosphoric acid in the form of acid phosphates, or to the presence of some organic acid, or to both phosphoric acid and an undetermined organic acid.

The latter supposition is certainly correct in some diseases, as malarial fever, in some stages of which phosphoric acid almost entirely disappears; whilst the urine still preserves a strong acid reaction.

The rapid disappearance of the free acid in the urine of convalescence, a few hours after it was voided, was by no means an index of an absolute diminution in its quantity, but was rather the result of the rapid changes of the urine, induced by the hot weather, and of those changes in this excretion which were dependent upon a full diet. The increased susceptibility to change in the urine in convalescence, may also arise from the more unstable constitution of the urinary excretion during that state of the system, which is characterized by a return of appetite, an arrest of the waste of tissue, and the formation of new, living or organized matter.

(*e*). *Phosphoric Acid.* The phosphoric acid was increased during the active stages of the disease, and gradually diminished in amount after the cessation of the spasms.

The increase of phosphoric acid was coincident with the spasms; the decrease was coincident with the cessation of the spasms.

After the relaxation of the jaws, and the return of the appetite, the amount of phosphoric acid excreted by the kidneys greatly increased. Thus, during the active stages of the disease, the following amounts of phosphoric acid were daily excreted: July 8th, grs., 16.32; July 9th, grs., 39.96; 10th, grs., 45.76; 11th, grs., 16.94; 12th, grs., 12.87; average amount for July 13th and 14th, grs., 39.01; 15th, grs., 37; 16th, 16.3 grs.; thus giving an average during the nine days, when the spasms were in greatest intensity, of grains 28.03.

During convalescence, on the other hand, the following amounts of phosporic acid were daily excreted: July 17th, grs., 5.67; 18th, grs., 12.64; 19th, grs., 20.59; average July 20th and 21st, grs., 20.78; average July 22d and 23d, grs., 21.25 July 24th, grs., 17.79; average July 25th and 26th, grs., 13.98; average July 27th and 28th, grs. 28.76; July 31st, grs., 15.98; average for these 13 days, grs., 18.63.

In settling definitely, whether the phosphoric acid was increased or diminished during the different stages of the disease, it is necessary to establish the amount of phosphoric acid which is excreted under similar circumstances of rest and starvation. By these data we will be able, not merely to determine whether the phosphoric acid was actually increased or diminished, but will also be enabled to discover the effects of partial starvation upon the excretion of phosphoric acid, and thus eliminate the true effects of the disease.

Dr. Breed, from thirty examinations of urine of four healthy persons, determined the average daily amount of phosphoric acid to be, grains, 57.44; Neubauer, in the first individual, grains, 47.86; in the second individual, grains, 24.70; average for twenty-four hours, grains 36.28; Mosler, first series, 37.05; second series in the same individual, grains, 57.12; average grains, 45; Dunblkenburg, grains, 32.94; Kaupp, 35.46; Bencke, 39.21; Ranke, 41.53; Aubert, grains, 43.23.

The mean of twenty-five sets of observations collected by Dr. Parkes, was 48.8 grains a day.

Dr. William Hammond determined the amount of Phosphoric Acid excreted by himself under different circumstances of increased and diminished intellectual labor, and under the use of tea and coffee. During these experiments Dr. Hammond lived generously, for he says: "during the twenty-four hours, I consumed sixteen ounces of fresh beef, (boiled and roasted), twelve ounces of bread, one ounce of butter, eight ounces of potatoes, and two drachms of common salt. In the same period I drank thirty-two ounces of water. No other food, solid or fluid, was taken into the system."

Under ordinary exercise and intellectual work the average daily amount of phosphoric acid excreted during ten consecutive days was, grains, 43.66; during a similar period, under increased mental exertion, grains, 66.15; under diminished mental activity, grains, 25.10; when tea was used, grains, 38.07; coffee, 43.94.

If we compare the amount of phosphoric acid excreted by healthy, active, well-fed men, as above indicated, with the results obtained in the first case of Traumatic Tetanus, we might, if the peculiar circumstances of the case were left out of view, conclude that the phosphoric acid was actually diminished in Traumatic Tetanus. Correct conclusions, however, can only be drawn from a comparison instituted upon results obtained with individuals similarly situated.

Abstinence from food, or from food containing phosporus and its compounds, diminishes the amount of phosphoric acid in the urine, but does not, as in the case of chloride of sodium, cause its entire disappearance, for, whilst a large portion of this acid excreted by the kidneys, is derived from the portions of food which accomplish their offices without entering into the actual composition of the various structures, still the portion, which varies according to definite laws, is derived from the changes of those structures, which normally contain phosphorus and its combinations, as the nervous and muscular structures. Thus, Mosler found, during abstinence from food, that the phosphates of the urine sunk to half the ordinary quantity; whilst, on the other hand, under larger amounts of albuminous substances consumed as food, the amount of this constituent of the urine was doubled.

The experiments of Dr. Hammond, from which we have before drawn facts for comparison, are still more striking than those just referred to, and enable us to settle definitely the question of the increased production and excretion of phosphoric acid in Traumatic Tetanus.

Dr. Hammond confined his diet to the well-washed albumen of the serum of bullock's blood, and his drink to distilled water, for ten days; during this period, his strength progressively declined, the pulse increased in frequency, and upon the ninth day a serious diarrhœa, with thin, dark brown discharges commenced, and was attended with loss of appetite and disturbed rest; and upon the 10th day the diarrhœa continued with increased violence, the debility was so great that the experimenter was compelled to lie down, and the intellectual faculties were somewhat confused. The following amounts of phosphoric acid were excreted daily: First day, grs., 36.17; second, 34.17; third, 45.21: fourth. 22.29: fifth. 17.25: sixth. 18.45: seventh, 13.17; eighth, 11.08: ninth. 10.52: tenth. grs., 9.15: average amount of phosphoric acid excreted daily during the ten days' subsistance on albumen. grains. 22.04.

During a similar investigation upon the nutritive value of starch, Dr. Hammond suffered in a like manner. with headache. derangement of the bowels, loss of appetite and great debility. Amount of phosphoric acid excreted daily, upon starch diet: First day, grains. 27.18; second. 25.07; third. 26.61: fourth. 18.29; fifth, 10.55; sixth, 5.64: seventh. 5.70: eighth. 5.86: ninth. 5.50; tenth. 5.31; average for the ten days, grs. 13.66.

In the experiments upon the nutritive value of gum. pure gum Arabic was the article used. and nothing farther than distilled water. or rain water, was taken. The injurious effects arising from this article of diet were far more rapid and obvious than those previously recorded: hunger. pains in the bowels. face, and great debility induced Dr. Hammond to discontinue the experiments upon the fourth day. Amount of phosphoric acid excreted during the experiments upon gum: First day, grains, 24.14; second. 13.35; third. 7.09: fourth. 4.55: average amount of phosphoric acid for four days. grains, 12.28.

If it be borne in mind that Dr. Hammond weighed over 225 pounds, and at least one-third more than the patient (case 1st) suffering with Traumatic Tetanus, and that he was furnished with far larger supplies of nourishment than that consumed by the patient. and that he certainly. in the experiments upon albumen received larger supplies of phosphorus and phosphoric acid in his food. it must be admitted that during the active stages of Tetanus. the phosphoric acid in the urine is greatly increased above the amount normally excreted by strong. healthy men. similarly situated as to diet and rest.

This increase of phosphoric acid in the urine during the active stages of Traumatic Tetanus. must be referred to the increased nervous and muscular actions.

(*f*). *Sulphuric Acid.* The sulphuric acid. in like manner with the phosphoric acid. but in a less degree. was increased during the active stages of the disease.

The following amounts of sulphuric acid were excreted daily during the active stages: July 8th. grains. 11.28: July 9th. 21.24; 11th. 15.56; 12th, 9.57; 13th and 14th, daily average. 33.73; 15th. 38.34: 16th. 77.67. A portion of this sulphuric acid, especially in the highest figures. was. without doubt. derived from the sulphate of magnesia. adminstered as a purgative: the sulphate of quinia. daily administered, may, in like manner. have. to a small extent. increased the amount of sulphuric acid. If we exclude the figures. which were evidently affected. to a certain extent, by the sulphuric acid of the sulphate of magnesia. and if we accept the results of the observations of Clare. Gruner. Neubauer. Parkes and others. and place the daily amount of sulphuric acid excreted by healthy men. at between twenty and thirty-eight grains, with a mean of thirty-one grains. it is evident that the truth of the statement, with reference to the increase of this acid during the active stages of this case of Tetanus, will not be evident without farther consideration of the amounts of this constituent of the urine excreted during circumstances similar to those in which this patient was placed.

The experiments of Lehmann. Vogel. Clare and others have shown that the character and amount of the food influences the amount of sulphuric acid discharged by the kidneys: animal food increasing. and vegetable food diminishing the amount of sulphuric acid.

The experiments of Dr. Hammond furnish reliable data for the determination of the question now under consideration.

Upon the albumen diet. the following amounts of sulphuric acid were excreted daily: First day. grains. 28.65: second. 23.65; third. 29.18; fourth, 21.18; fifth, 15.12; sixth, 12.18: seventh. 10.73: eighth, 11.24: ninth. 8.96; tenth, 8.36; average for ten days. on albumen diet. grains 16.92.

Upon starch diet. first day. grains. 30.45; second, 19.68; third, 12.07, fourth, 10.56; fifth. 6.70; sixth. 4.12; seventh. 3.81; eighth. 3.09; ninth, 2.60; tenth, 2.26; average for ten days on starch diet. grains, 11.12.

The comparison of these results demonstrates conclusively that the sulphuric acid *was increased* during the active stages of Tetanus.

Recent investigations have not confirmed in all respects, the observations of Berzelius and others, with reference to the presence of sulphuric acid and sulphates in any considerable amounts in the juices of flesh; and they point to the kidneys and blood as the positions where these chemical changes are completed, in the final conversion of the sulphur of the albuminous compounds, into sulphuric acid. The absence of sulphates from the juices of muscle, may also be due to the constant passage of these salts from the muscular fibre into the blood; and the continuous and efficient elimination of the elements or compounds, by the kidneys. Whatever view we adopt with reference to the formation of sulphuric acid in the animal economy, it is evident that its increase, during the active stages of any disease, indicates an increased change of those nitrogenous tissues which contain sulphur. It is reasonable to suppose that the increased amount of the sulphuric acid eliminated during the active stages of this case of Tetanus, was due to the more rapid chemical changes during the severe spasms.

(*g*). *Chlorine—Chloride of Sodium.* The chlorine was diminished during the active stages, but gradually increased, and finally attained the usual standard during convalescence.

Thus, the following amounts of chlorine were excreted during the active stages: July 8th, grains, 31.68; 9th, 45.22; 11th, 10.59; 13th and 14th, average each day, 38.83; 15th, 16.53. A portion of the chlorine, and perhaps a greater part of it, may have been derived from the chloroform administered internally. This statement, however, would admit of extensive discussion, and perhaps the ultimate facts as to the amount and character of the transformation of chloroform in the living body are wanting.

During convalescence, the following amounts of chlorine were excreted: July 17th, grains, 5.25; 18th, 23.17; 19th, 37.82; average daily amount during July 20th and 21st, 42.42; average 22d and 23d, 68.70; 24th, 107.79; average July 25th and 26th, 64.03; average 27th and 28th, 94.56; August 1st, 120.30.

It is important that we should determine whether the decrease of the chlorine during the active stages of the disease be the result of diseased action or of physical circumstances, as the character and quality of the food, aside altogether from the effects of disease. We must, in settling this question, determine the effects of circumstances similar to those in which this patient was placed, upon the excretion of chlorine in the urine of healthy men.

Hegar, from a series of accurate observations upon eight young gentlemen, students at the University of Geissen, found the average daily amount of chlorine discharged in the urine to be 161.96 grains.

According to Parkes, the daily amount of chlorine discharged by healthy men, ranges from 51.87 to 58.05 grs. J. Vogel gives 92.06 grs. as the daily average; and Buckheim, 105.6; Mosler, 108.23; Bischoff. 134.32; Neubauer, 136.87; Wilde, 145.60; Hammond, 154.80; Kaupp, 155.94: Kerner, 156.71; Bencke, 162.12; Genth, 173.23; mean of the results obtained by these observers, grains, 126.76. If the whole of this chlorine were united to sodium, it would make nearly 210 grains of chloride of sodium; an amount which Dr. Parkes considers as too large; and this distinguished observer believes that it is safe, with Vogel, to put the amount of chlorine at 7 grammes, which would give nearly 11½ grammes, or 177 grains of chloride of sodium in twenty-four hours.

If these results be accepted as correct, then there was a most decided diminution of chlorine, during the active stages of Tetanus.

The naked statement of this fact, would at first excite interest, because Rethenbacker, Vogel, Beale, Thudichum, and others, have shown that in Pneumonia, and in fact in acute febrile diseases, generally, the amount of chlorine discharged in the urine, rapidly decreases, and even disappears entirely for a short time, and then as the diseased action abates, the amount increases during convalescence. Viewed in this connection, this fact would seem to oppose the view, previously recorded, and to indicate that there was some true inflammation, or febrile excitement in this case of Tetanus.

To settle this question, we must determine, whether the diminution of chlorine may not have been entirely due to the state of partial starvation in which the patient was placed by the disease, and the consequent absence or diminution of chlorides in the food. It is now well established that the chlorine discharged by the urine, is almost entirely derived from the chlorides (chiefly Chloride of Sodium,) of the food, and consequently differs in amount in different individuals, and varies in the same individual in accordance to the amount and character of the food consumed: it results from this, that during starvation, even in health, the chlorine will rapidly diminish, and may almost entirely disappear. Thus, Dr. Hammond, upon a diet of Albumen, excreted the following amounts of chlorine during twenty-four hours: First day, grains, 30.54; second, 21.54; third, 10.45; fourth, 5.37; fifth, 5.01; sixth, 4.22; seventh, 3.61; eighth, 3.25; ninth, 2.39; tenth, 2.12; average during ten days subsistence on Albumen, grains 8.86: upon an exclusive diet of starch, with pure water for drink, as in the previous experiment: First day, 85.26 grains of chlorine; second, 31.04; third, 14.27; fourth, 8.41; fifth, 8.03; sixth, 6.22; seventh, 4.74; eighth, 4.30; ninth, 3.01; tenth, 1.89; average grains, 16.71: upon an exclusive diet of gum, first day, grains, 46.28; second, 21.15; third, 6.33; fourth, 3.20; average grains, 19.21 of chlorine.

The results of these investigations, enable us to affirm, that the decrease of chlorine in the urine, during the active stages of the *first* case of Traumatic Tetanus, was due to the limited amount of food, and consequently, the limited amount of chlorides consumed by the patient, and not to any inflammatory condition, similar to Pneumonia, and the acute stages of certain febrile diseases, as Typhoid Fever and Small-Pox.

From this extended examination and comparison of the phenomena manifested during the progress of the first case of Traumatic Tetanus, for the continuous investigation of which we enjoyed unusual advantages, and to which a large amount of time was devoted, we draw the following general conclusions:

1st. The essential phenomena of inflammation were absent. The phenomena were exaggerated manisfestations of nervous and muscular actions. An irritation in a distant nervous branch was propagated to the spinal cord, and the disease, after its establishment, appeared to be dependent upon an exalted excitability of the entire spinal ganglia, as manifested in the greatly exaggerated reflex actions.

2d. The increased actions in the nervous and muscular systems, were attended by corresponding changes in the materials composing these structures, thus indicating that the two were intimately connected and were even dependent upon each other in the relation of cause and effect. In these phenomena of the human organism, as well as in the physical and chemical phenomena of the exterior world, we find no exception to the law, that for the production of definite physical, and the *so-called vital actions* and results, a certain amount of matter must be chemically altered: that is, be deprived of, or emit, a certain amount of force, inseparably connected with certain forms and combinations of matter.

3d. The phenomena during the active stages of Tetanus, point to a change in the electric conditions and relations of the nerves and muscles.

We will not now discuss the question, as to whether the peculiar spasms of Tetanus were caused by a *pre-existing* change in the conditions and relations of the muscles, or whether they were directly traceable to the transmission of the irritation from the wound; but will confine our attention to the examination of those facts which throw light upon the physical phenomena of the nerves and muscles, during their violent manifestations in Tetanus.

We have discussed at length, in the Physiological introduction, the relations of the muscular and nervous forces: and shown that:

a. There is a close analogy between the structure and mode of action of the electric organs of certain fish, and the nerves and muscles of living animals.

b. Animal life is not possible without constant chemical and physical changes in the molecules of the body; and since such disturbances are always accompanied with the liberation of electricity, we infer that electrical currents exist in all living structures, and that the intensity of these electrical actions, varies with the amount and character of the physical actions of the tissues.

c. Electrical currents circulate in all tissues in which active nutrition is carried on, and the electro-motive force, is strongest and at the same time is capable of the greatest and most sudden variations in intensity and direction in the nerves and muscles.

d. There exists, both in the muscles and in the nerves of all animals, a natural electricity, which is manifested under the form of closed circuits, circulating along the muscles, or nerves of the animal, and of which we can collect, but a very small derived portion, by the assistance of our instruments; and the preservation of this free electricity, is subordinate to the state of life of the animal, and disappears with the cessation of the normal chemical and physical changes characteristic of life.

e. An electro-physiological law of great interest, in the study of the phenomena of Tetanus, has been established by DuBois Reymond, for the motor nerves, and may be expressed thus: the motor nerves are not excited by the absolute amount or density of the current, but merely by the variations which occur in the density of the current, from one instant to the other, and the more considerable the variations in the density of the current, the greater the physiological effects. It results from this, that unstable conditions of the closed, muscular and nervous currents dependent upon derangement of the chemical and physical properties and actions of the molecules of the muscles and nerves, would be necessarily attended by deranged muscular and nervous actions: variations in the density of the currents circulating in the motor nerves, may be attended with either exaltation or depression of muscular action.

f. Contractility is inherent in the muscles: and is not the result of a force communicated to the muscles by the nerves. The muscles do not derive their state of tone, or power of contractility from the cerebro-spinal and sympathetic nervous systems, but possess within themselves, all the conditions necessary for the generation of their proper force.

g. The muscular force results from the chemical changes involved in the healthy nutrition of the muscles; the chief influence of the nervous system, therefore, upon the muscular system, is by the disturbances of the electrical condition, and by an influence upon the nutrition of the muscle, through the variations of the amount of blood circulating through the muscular structures.

h. If in the state of health, the molecules of the nerves and muscles are retained in a particular arrangement, by the vital force, and if under the action of the will, or other causes determining muscular contraction, or relaxation, this arrangement is modified, so as to become similar to the condition of a conductor transmitting an electric current, it is probable that when derangement of the molecules is caused by almost every cause, however slight, capable of dirturbing the electric equilibrium, and even beyond all control of the will, and even so powerful in its effects, as to rend asunder the muscular structures, there is either a want of proper action of the vital force, in preserving the mutual and definite relations of the molecular forces, or an undue activity in the molecular changes in the nerves and muscles. We have previously demonstrated, that during the active stages of Traumatic Tetanus, there is an increased chemical change of the nerves and muscles; we must conclude therefore, that the disease is due not only to a disturbance in the electrical conditions and relations of the nerves and muscles, but chiefly to a great augmentation of the intensity of the electrical actions in both nerves and muscles. This view is further sustained by the fact, that the contractions of the muscles in tetanus are far more violent and prolonged than those of health, excited by any cause whatever, internal or external, by the will, or by mechanical stimuli—so violent in fact, that the muscles are frequently ruptured, and that too, against no other points of action, than the bony levers, and in no other action, than in that of simple involuntary contractions; and by the equally striking fact, that a continuous current of electricity may, when passed in a certain direction, relieve the spasms of Tetanus.

i. If it be true, that the nervous force is electricity, or a modification of electricity, and if all the chemical actions in the body, develop this force, together with heat, it follows as a necessary consequence, that nerves may be capable of influencing secretion, in virtue of the power which their active force has of exciting chemical change. Thus an impulse originating in the central masses of nervous matter, or reflected from the circumference, may be propagated by changes of the molecules of the nerves, and reproduce its original effects, by transmission to distant organs. We would thus have an example of chemical change in the periphery of the nerves, and in the various organs, whether muscular or secretory, to which they are distributed, analogous to that which takes place, at the terminals of the galvanic battery.

In Tetanus, where there is an exaltation of the acts of the ganglionic cells of the gray matter of the spinal axis, constant impulses are sent out to the voluntary muscles, and to the sympathetic, in virtue of the nervous connections, between the two systems; and thus the ganglionic cells of the sympathetic become in turn excited, and the organs to which this system is distributed, such as the kidney, liver, and alimentary canal and heart, are in turn affected.

CHAPTER III.

OBSERVATIONS ON THE PATHOLOGICAL ANATOMY OF TRAUMATIC TETANUS. COMPARISON OF THE PATHOLOGICAL CHANGES IN THIS DISEASE WITH THOSE OF INSANITY, EPILEPSY AND PARALYSIS. GENERAL CONCLUSIONS AS TO THE NATURE OF TETANUS AND ITS RELATIONS TO CLIMATE AND CHANGES OF TEMPERATURE.

Observations on the Pathological Anatomy of Traumatic Tetanus. Comparison of the Pathological changes in this disease, with those of Insanity, Epilepsy, and Paralysis. General conclusions as to the nature of Tetanus, and its relations to Climate and changes of Temperature. Cases illustrating the Pathological Anatomy of Tetanus. Blood-vessels of gray matter of spinal cord congested and dilated. Discussion of the cause of the congestion and dilatation. Analysis of the investigations of various anatomists and physiologists, upon the effects of congestion of the blood-vessels of the spinal axis: more especially of S. Weir Mitchell and Benjamin Ward Richardson. Analysis of the labors of various pathologists with reference to the lesions of Traumatic Tetanus, as Morgagni, Rokitansky, Larrey, Dupuytren, Pellitier, Hennen, Craigie, Curling, Copland, Parry, Travers, Sandwith, William Aitken, Lockhart Clarke, Dickinson and others. Comparison of the lesions, characteristic of Traumatic Tetanus, with those of Insanity, Paraplegia, Hemaplegia and Epilepsy. Cases. Relations of Traumatic Tetanus to soil and climate. Statistics of various Cities, as London, Philadelphia, New York, Boston, Calcutta, Savannah, Charleston, Augusta, Nashville and New Orleans. Relative prevalence and fatality of Tetanus, in White and Black races.

PATHOLOGICAL ANATOMY OF TRAUMATIC TETANUS.

IN the preceding chapter, I endeavored carefully to investigate the phenomena presented by a typical case of Traumatic Tetanus, and to interpret the characteristic manifestations, by the light of Physiological and Pathological observations, experiments and researches.

We desire in the next place, to determine, whether any *pathological alterations* are recognizable after death from Traumatic Tetanus, which can be associated with the abnormal manifestations during the progress of the disease.

In this inquiry we will endeavor to pursue the inductive method, first presenting our own observations, and then comparing them with the facts recorded by other pathologists.

Case 21: Traumatic Tetanus; Life of the patient preserved temporarily by Marshall Hall's Ready Method; post-mortem examination. Structural Alteration of Cord.

J. A. Rouk, Company K., 1st Alabama Cavalry, Hagan's Regiment; private; age, twenty-one; black hair; fair complexion; nervous temperament; admitted in the Third Georgia Hospital, Augusta, Ga., February 11, 1865. Was wounded February 2d, in a skirmish, near Alendale, S. C., by a ball from a Spencer rifle. The ball passed through the abdominal muscles of the right side, one inch above the crest of the ileum, entering anteriorly. Distance from one orifice of the wound to the other, about four inches. From all appearance the ball passed entirely within the muscular structures of the wall of the abdomen, and did not penetrate the cavity. Patient's health good, before the reception and at the time of this wound. After being wounded, he was sent to the Division Hospital, in which he remained nine days, moving along with the hospital in ambulance to Augusta, Georgia. During this time the wound was dressed once a day, and kept moist with a wet rag. Patient felt well during that time, but when entering the hospital, complained of cramps (to use the patient's own expression) in the wounded side and back.

On the 12th of February, Opisthotonos gradually commenced. From 10 A. M., one tea-spoonful of Laudanum (Tincture of Opium) was administered every one and a half hour, until 6 o'clock P. M., (the whole quantity of Laudanum given up to this time was about one wineglassful, which produced no perceptible effect.) No medicine given during the night—patient slept very little. One natural evacuation of bowels this day.

February 13th. Trismus commenced this day, Chloroform was given by inhalation, which allayed the nervous irritation for about one hour. This was continued during the day, with the addition of one tea-spoonful of Chloroform, and another of Laudanum, administered internally every three hours, until three doses were taken, when the trismus increased to such an extent as to prevent deglutition. The Chloroform appeared to diminish the volume of the pulse. Respiration during the day, tolerably easy. The tongue, as far as could be seen, natural. Condition of skin natural, sometimes moist. Bowels constipated. Urine natural in color and quantity.

February 14th. Trismus and opisthotonos increased. Respiration more labored. Injection of Turpentine and Castor Oil given with no effect. One tea-spoonful of Chloroform, Laudanum and Ether, mixed in equal quantities, were given by the mouth, every three hours, with no perceptible effect.

February 15th. Tetanic symptoms increased. Respiration more labored—no evacuation of the bowels. An enema composed of one tea-spoonful each of Tincture of Camphor and Tincture of Opium (Laudanum) was given every three hours. No benefit appeared to be derived from this mode of medication and it was discontinued.

Patient continually kept under the influence of Chloroform, to relieve his sufferings—no sleep obtained without Chloroform.

February 16th. Symptoms increased in severity—deglutition more difficult—Chloroform continued by inhalation.

An attempt was made to administer egg-nogg, by the mouth, but failed—patient could not swallow, and immediately after the efforts, was seized by a violent tetanic spasm. In the spasm, the muscles of respiration became involved, which soon arrested the thoracic respiration, so that the latter function was only performed by the diaphragm and abdominal muscles. At length, however, these muscles also became involved, and respiration ceased entirely. The patient's face turned blue and livid, the black blood overcame the cerebro-spinal system, the eyes were fixed—all signs of life disappeared, and death from the asphyxia appeared already to have taken place.

Artificial respiration after the method of Marshall Hall, was established and kept up for a few minutes, when the patient gradually revived. The spasms of the respiratory muscles also gradually relaxed, and after sometime, the patient commenced to breathe again naturally.

At this time two ounces of whisky with one tea-spoonful of Chloroform, were administered by enema. This was kept up with the addition of half a pint of beef-tea, every two hours until the evening; with the exception of the Chloroform, the supply in the hospital having given out.

Evening—patient more quiet—pulse 100; respiration more easy—conversed and swallowed half a glass of water. Patient remained in this comfortable condition, affected with an occasional slight spasm. About 3 o'clock, A. M., he asked for water—a little was given him, which brought on another slight spasm, during which he expired about ten minutes after taking the water. This spasm was similar in its nature to the one already described and it is highly probable that if the method of artificial respiration, had been practiced, the life of the patient might again have been prolonged.

In viewing the Tetanic spasms of this patient, we were forcibly reminded of the graphic description of Aretæus* the Cappadocian.

Sixteen Centuries have not impaired the accuracy or force of this picture.

Autopsy six hours after death.—Spare but muscular man; rigor-mortis very strongly marked—hands contorted and fingers clenched; and feet twisted as in srychnine poisoning.

The brain and spinal marrow carefully removed. The nerves leading from the spinal marrow, to the wound, were also carefully dissected and examined in situ. The entire mass of flesh surrounding the wound, was then examined, and together with the spinal cord and its nerves and muscular attachments were removed.

Condition of the wound.—The wound was a superficial flesh wound. The ball was a small one, apparently not larger than a pistol ball, and had passed directly through the structures without lacerating them.

When the tetanus first manifested itself, the discharge from the wound is said to have greatly diminished, and almost entirely disappeared. Several days before death, however, and up to the close of life, the wound secreted small quantities of pus. When the entire tract was laid open, it was found to be granulating throughout its entire extent. The granulations were carefully examined with a magnifying glass. They were small and rather pale The wound was dryer than usual, that is there was less discharge than in healthy wounds.

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*The Extant Works of Aretæus, pp. 247—249.

Under the microscope, the pus presented an unhealthy appearance. The corpuscles were small, few in number and imperfectly formed, and amorphous granules abounded.

The wounded surface was surrounded or underlaid by a thick fibrous wall, the result of inflammatory action.

In the track of the ball, numerous sharp filaments of wool, were found sticking into the granulations, and passing in some cases, entirely through the fibrous wall, to the muscular structures beneath.

Nerves supplying the diseased parts.—These were dissected, and traced into the parts immediately surrounding the wound. These nerves presented no distinct evidence of congestion or inflammation.

Spinal Marrow.—The nerve leading from the diseased and wounded part, was the *last dorsal.* This sent off a branch to the *lumbar plexus;* for two inches above its junction with the spinal cord, the blood-vessels of the cord were engorged with blood, and the vessels presented a marked enlargement.

The congestion extended from thence, to the termination of the spinal cord, and the corda equinæ was also much congested. The thigh upon the affected (right side), had been quite stiff at the hip. The congestion was greatest upon the posterior surface of the cord.

Sections of the cord were made at the various parts, from the junction of the medulla oblongata, with the pons varioli, to the termination of the spinal cord, and the gray matter presented a pinkish, deep colored congested appearance.

Both the gray and white substances, were examined carefully under the microscope, the nerve fibres presented the usual appearance; the cells of the gray matter appeared indistinct.

The blood-vessels of the gray matter were filled with red corpuscles.

This case presented the following points of interest:

1st. The restoration of the patient, after apparent death, by artificial respiration, was a matter of importance.

The life of the patient was prolonged at least eighteen hours by this method.

A large portion of the cases of tetanus, terminate fatally from spasm of the respiratory muscles. If artificial respiration had been practiced the second time, it is probable that the patient would again have been restored. The narcotic effects of the Carbonic Acid of the blood, tend to overcome the spasms, and hence the possibility of instituting artificial respiration.

This subject is worthy of most careful consideration, and of practical application in this terrible disease.

2d. The granulations and the pus of the wounded surface were imperfectly formed; and it is not unreasonable to suppose that the irritation of the injured nerves may have arisen in a measure from these unhealthy products of inflammation. The particles of wool penetrating the tissues, may also have been exciting causes of the peculiar nervous disturbances. It is important that the most careful examination should be instituted of the wounded parts and products of the consequent inflammatory action.

3d. The gray matter of the spinal cord, was decidedly congested with blood; and the congestion was so great, as to render this portion of the cord of a decidedly reddish pink color.

Tetanic spasms were attended with great waste of the nervous and muscular elements, and especially of the former, as I have shown by careful analysis of the urinary excretion in this disease.

The gray cells of the spinal cord, and medulla oblongata, during the stages of action, excitement and change, need an increased and sufficient supply of blood.

4th. The tetanic spasms in this case, were attended with palpable lesions of the spinal cord; and the most prominent condition of this state was hyperæmia.

Case 22: Traumatic Tetanus; death; cerebro-spinal system examined after death; structural lesions discovered.

Julia Jackson, colored, aged nineteen, stout, athletic negro woman. Has never borne children.

On the 5th of March, 1869, a clothes-line pole fell upon her left shoulder, and a splinter passed downwards and forwards, under the skin, over the deltoid muscle. On the 15th of March, after the wound had apparently entirely healed (the injury was very slight, and the splinter was removed immediately after the reception of the blow), the jaws became stiff, and tetanic symptoms manifested themselves.

Entered the [illegible] Hospital, New [illegible] March [illegible], two weeks after the reception of the injury [illegible] body drawn towards the left arm and side [illegible] had been injured. Patient complained of pain in left arm, shoulder and side.

The attending [illegible] and Bromide of Potassium, beef-tea and brandy [illegible] grain and a half of [illegible] and ten grains of the Bromide of Potassium every three hours. [illegible] the spasms, and the patient enjoyed some rest.

On the [illegible] of March [illegible] the plan of treatment was changed, and one-twelfth of a grain of Strychnine [illegible] The patient took only two pills, and died soon after the administration of the second pill, [illegible] of tetanus. The contraction of the muscles of the left side and arm continued [illegible] the moment of death; and the patient appeared to die from spasm of the respiratory muscles and asphyxia. The preceding facts were furnished by the attending physician.

Autopsy [illegible] — The brain and spinal cord, [illegible] were removed from this stout young negro [illegible] the firmness and roundness of great muscular power and of the most robust health.

The pia-mater of the brain and spinal cord were greatly congested with blood; the congestion was greater at the base of the brain around the medulla oblongata. The gray and white matter of the cerebrum presented the usual consistence, but the cerebellum appeared to be somewhat [illegible] than usual. The gray matter of the spinal cord was universally congested [illegible] the white matter was softened. The white matter protruded from the smallest punctures of pia-mater and arachnoid membrane of the cord.

The most marked [illegible] were [illegible] in the floor of the fourth ventricle. The blood-vessels of the [illegible] were [illegible] greatly congested, but a small quantity of blood was effused [illegible] of the fourth ventricle, beneath the arachnoid membrane and [illegible] of the pia-mater.

The internal viscera were [illegible] examination presented nothing abnormal, with the exception of the [illegible] resulting from the sudden arrest of the process of respiration.

The lung on the left side was congested [illegible] and presented a marked difference in this respect from the right lung, which presented some congestion only in its most dependent portions. [illegible] lung appeared to be due in a measure to the contraction of the muscles [illegible] and the consequent interference with respiration; but it is also probable that [illegible] of the function of the pneumogastric nerve on this side may have been [illegible]

The seat of the wound was examined with great care. Two cicatrices were observed, the one [illegible] and the other near the axillary fold.

An incision [illegible] thickening of the texture, but the injury had healed [illegible]

[illegible] walls, filled with about two drachms of [illegible] apparently resulting from the [illegible] occupying the upper surface of the [illegible] were found, about half an inch in diameter [illegible] and undergarment, by the splinter, [illegible] were the only apparent cause of the abscess [illegible] was discovered upon careful and minute dissection.

[illegible]

1st. [illegible] and appeared rather to aggravate the symptoms.

2d. [illegible] the presence of the particles of clothing. [illegible] spasms had been diagnosed during life, it might have [illegible] laying it open, and exciting healthy suppuration.

3d. [illegible] which the injured arm was attached. The [illegible] abscess were more congested than those [illegible] was reflected most strongly [illegible] nerves from the same lateral half of the spinal cord.

4th. [illegible] abscess differed widely from the products of [illegible] matter, may have been one of the exciting causes of the [illegible]

5th. [illegible] palpable lesions, in the congestion of the blood-vessels [illegible] of the white matter.

In both the preceding cases the blood-vessels of the gray matter of the spinal cord were dilated and congested with blood. That the congestion was not dependent upon

ges induced during the last hours of life, or subsequently to death, were clearly
n by the fact that the patients died suddenly before the powers were exhausted,
lso by comparative examinations of the cord after death from other diseases.

vo questions immediately present themselves for discussion:

t. What was the cause of the dilatation and congestion of the blood-vessels of the
l cord and medulla oblongata?

. Did the dilatation of the blood-vessels of the spinal cord and medulla oblongata
any relations to the tetanic spasms?

the first chapter we have dwelt upon the experiments of Bernard and Brown-
ard, showing that when the branches of the sympathetic nerve leading to any part
animal's body are divided, the arteries of the parts become fuller, and the tem-
ure is raised by the increased quantity of blood which runs through; and that
, on the other hand, the same branches are excited by an electric influence, the
ies contract, and the blood is driven out, and the temperature descends.

was thus shown that the great sympathetic plays the part of a constrictor to the
arteries, and slackens the capillary circulation; when, therefore, this nerve is cut,
mall arteries become paralyzed and proportionally relaxed, whilst, on the other
, exciting the action of the sympathetic by galvanism, causes such a constriction of
mall arteries that their area is greatly diminished or obliterated. The results of
experiments are manifestly dependent upon the anatomical structure of the arteries,
alls of which may be considered as practically consisting of yellow, elastic tissue, and
iped muscular fibres, the functions of which are in a manner antagonistic to each
, for, whilst the contraction of the unstriped muscular fibres of organic life tend to
the calibre of the arteries, the elasticity of the yellow elastic tissue, tends to restore
rea to a constant form; when, therefore the nervous influence supplied to the arte-
alls is cut off, the vessels dilate, because the yellow tissue still exerts its elasticity,
the muscular coat is paralyzed. By these means, the distribution of the blood,
h is sent out in an intermittent manner by the heart, is regulated by the action of
rteries. It is also well established by the existence of the circulation in the lower
als devoid of a central organ of circulation, and in the heartless fœtus, which lived
al days after birth, and in animals after the heart has been cut off from the vessels
ligature, that the arteries have a propulsive force in themselves, independent of
elasticity, and of the action of the heart, which has been compared to the peri-
c action of the intestines.

e researches of Messrs. Legros and Onimus, (Recherches, Experimentales sur la
lation, etc., Journal de l' Anatomie et de la Physiologie, 1868, 1869, 1870),
rendered it probable that there is a peristaltic movement of the microscopic
ies in man as well as in the lower animals.

e attention of these observers was first aroused by the fact, that in the normal
tion the contraction of unstriped muscular fibre is rarely spasmodic or in mass,
ontinuously alternate, wavy and vermicular, and they argued that the blood in the
les was most probably passed on by a movement similar to that which propels the
nts of the digestive canal. The experiments of Messrs. Legros and Onimus, on
animals, where the cardiac action has been annulled by tying the large vessels,
shown that their circulation is continued for a certain short period even in mam-
, and for a much longer time in cold-blooded animals; and in animals when the
athetic has been divided on one side, and the action of the heart paralyzed by
ns, such as chloroform or alcohol, the temperature is found highest on the side
e the sympathetic has remained untouched; thus showing that the small arteries
ss a power over the circulation of the blood independent of that of the heart, and
the action of the sympathetic is to enable the small arteries to propel the blood,
e alternate contractions and peristaltic movements of the unstriped muscular fibres.
e experiments not only sustain, but enlarge and magnify the results obtained by
le Bernard. It is thus rendered probable that the movements of the microscopic
ies are consecutive upon reflex action; that is, the impulse communicated to the

column of blood by the heart, progressively dilates the arterioles, the sensitive fibres of the sympathetic distributed to their walls transmit the impression to the ganglia, and the motor fibres acting on the contractile coat of the vessel, just as the digestive canal progressively presses onwards the digestive fluids and materials. According to this view, there is no necessary antagonism between the rythmical action of the heart and the peristaltic motion of the microscopic arteries. By this theory, also, we are enabled in a manner to comprehend the mode in which alterations in the quantity and chemical constitution of the blood, by blood-letting, and by the introduction into the vital fluid of remedial agents, as well as morbid products and poisons, may act upon the nerves of the blood-vessels, and by reflex action cause a diminution or augmentation of the current of blood supplied to each organ or tissue, and thus lead to disturbance of the normal secretion, and nutrition, and excretion. It is evident, therefore, that as the blood-vessels which supply each separate organ are regulated by a distinct department of the nervous system, external forces acting upon the nervous system may transmit their effects specially to these organs, and induce deranged secretion, nutrition and excretion, and such derangements may in turn, act upon the nervous system. If the controlling nerve force of the unstriped muscular fibres of the minute arteries be weakened or suspended, an alteration or suspension of the normal circulation must ensue; thus, when partial dilatation of the vessels has occurred from a slight degree of arrest of the peristaltic action of the unstriped muscular fibres, the powerful action (*vis a tergo*) of the heart drives the blood more fully and freely than is natural into the small arteries and capillaries, and active hyperæmia is established, which may be temporary or permanent, according to the action of the disturbing force upon that portion of the nervous system distributed to the blood-vessels.

Thus, we may have, on the one hand, every degree of hyperæmia, from the sudden and temporary injection of the capillaries with arterial blood, in blushing, and the throbbing of mental emotion, to the excessive secretion of irritation and incipient inflammation, and congestion, and stasis, leading to complete arrest of circulation, transmigration of colored and colorless corpuscles, and even rupture of the capillaries; and, on the other hand, such a degree of spasm of the unstriped muscular fibre of the minute arteries, as induces the diminution of temperature, and bloodlessness of the surface in the cold stage of fevers, and especially of Intermittent and Congestive Fevers. As is well known, in the cold stage of malarial fever, the surface is cold and pale, while the blood is accumulated in the internal organs and large vessels; and the action of a morbid poison is still farther shown in the rise of the temperature of the blood in the central organs and vessels.

During the cold stage of various diseases, and especially of malarial fevers, the arrest of the peristaltic action, and the spasm of the minute arteries act antagonistically to the heart; when, however, owing to the intermittent action of the organic system of nerves and muscles, the spasm passes off, there is a corresponding and consecutive dilatation of the small arteries, which admits an increased amount of blood, and thus the cold stage is succeeded by the hot stage, which is attended by increased respiration, circulation, chemical change and secretion. In malignant malarial fever, we may have fatal paralysis of the vessels of the brain, leading to coma, or of the liver, leading to destructive Jaundice and alterations of the colored blood corpuscles in the capillaries of the liver and in the spleen, or of the kidney, leading to hæmaturia, and complete arrest of the urinary excretion. In a similar manner the suddenly fatal effects of *sun-stroke*, have been referred mainly to paralysis of the blood-vessels of the brain and spinal cord, induced by the effects of increased heat and the altered blood loaded with carbonic acid gas. In some cases of *sun-stroke*, the temperature of the body attains an extraordinary degree in a short period of time, ranging from 110 to 115° F. Such a degree of heat must necessarily prove fatal, from paralysis of the muscular fibres of the heart and arteries, as well as from the necessary alterations of the blood and derangements of the cerebro-spinal and sympathetic nervous systems.

We are thus led by the researches of Legros and Onimus, to consider in a more orable light, the views of Stahl, Hoffman and Cullen, who perceived the importance the nervous system as a factor in disease.

We are therefore compelled in view of these facts, to regard the dilatation and con- tion of the small arteries of the spinal cord and medulla oblongata in Tetanus, as of at importance, and as indicating not only an increased functional activity (secretion) the central ganglionic cells, but also, paralysis or arrest of the action of that portion the sympathetic nervous system, which presides over the circulation of the medulla ongata and spinal cord.

The second question, viz: Did the dilatation and congestion of the blood-vessels of spinal cord and medulla oblongata, bear any relation to the tetanic spasms? now sents itself for discussion.

The experiments of Dr. S. Weir Mitchell of Philadelphia, upon the effects of cold the cervical spine, are of interest in the light which they throw upon the effects of ngestion upon the production of spasms and exalted reflex actions. I have repeated most important of these experiments, and obtained results similar to those announced Dr. Mitchell, in his article in the American Journal of Medical Sciences, 1866.

During the Spring and Summer of 1863, Dr. Morehouse, and Dr. Mitchell, engaged a prolonged research on the cerebro-spinal fluid, and the influence of pressure in ducing convulsions. When the small end of a tube, twelve inches long, and two limetres wide, (open at both ends, and drawn to a point at one extremity, and anded funnel-like at the other), was introduced into a minute opening through the mbrane which fills the occipito-altoid space, previously exposed by an incision in the ddle line of living rabbits, and pressure was made upon the medulla oblongata and nal cord, by means of water poured into the upper end of the tube, held upright, it possible, in this manner, to pour through the tube into the spinal canal, at least *f an ounce of fluid.*

At a certain point, usually when there was a pressure of ten inches in the tube, con- sions ensued and checked the experiment. Experiments were instituted to deter- ne the effects of water at different temperatures, and it was found that greater ssure, and more continued pressure was borne, with water at 100° F. than at 120° 60°; and when water at 32° F. was employed, spasms followed almost instantly on the introduction of the first few drops of fluid.

The convulsions which ensued, when water at 32° F. was introduced into the spinal d, were very remarkable; the animal rolled, turned, leaped, shivered, and in fact, hibited every variety of convulsive action, in remarkable perfection. This effect med to be due to the direct influence of cold on the medulla oblongata, since like ects were produced when a morsel of ice was laid gently upon that organ, or when it s exposed and ice water was dropped upon it. This very striking experiment led . Mitchell at a subsequent time, to test the possibility of suppressing the functions the central ganglia by the use of cold; and after numerous unsatisfactory experi- nts with ice and ice in salt-bags, applied to the spines and brains of rabbits, Guinea- s, and kittens, in 1863 and 1864, he finally made use of the valuable method of using local anæsthesia by cold, invented by Dr. B. W. Richardson, of London, and tained the following important results:

The method of research was much the same in each case: Richardson's atomizer was cessary when æther was used, in general, however, Rhigoline was employed with the l of a cross jet of air; in some instances, the atomized fluid was thrown upon the in, in others, upon the bony case of the nerve centres, and more rarely on the nerve bstance previously laid bare, or merely guarded by a thin patch of Caoutchouc; the imals employed, were pigeons, chickens, rabbits, cats and pigs.

When a jet of rhigoline was thrown upon the back of a pigeon's head, the bird ivered towards the close of freezing; when released, walked away, shook itself, cleaned feathers and bill; after an interval of one minute of apparent quietude and health, gan to move suddenly backwards, as if by its own will, and before each motion of s kind, squatted close to the floor, and as he began to move, threw the tail up and the head down, and to one side in a spasmodic manner. In the intervals between the backward motions, the bird sought a corner, and sank into a stupid condition, or else walked about as usual until either a backward motion overtook it, or the bird fell again into stupor. The bird was easily aroused from the stupor, and then appeared to be in full possession of all its faculties. The backward movements, at length became visible only as sudden checks which overtook the pigeon now and then while walking forwards.

The delay, before any noteworthy phenomena were seen, the sudden onset of a strange form of convulsive movements, the state of partial stupor following, and the healthy appearance of the animal, in the interval, reminded Dr. Mitchell of the symptoms of certain epileptic cases, and induced him to repeat the observations.

When the jet of rhigoline, was thrown lower down, so as to more exactly influence the cerebellum, the results were similar, with the addition of rapid somersaults backwards.

With the exception of the temporary cessation of spasms, these experiments developed no new facts, in addition to those previously established by mechanically injuring the cerebellum, but the following experiments opened a new field.

"A pigeon, whose cerebellum had been previously frozen many times, was chilled on both sides of *the neck* during one minute, by a double jet of rhigoline, at the level of both cervical vertebra, just above the junction of the neck to the body. When released, he became at once the sport of violent general convulsions. They were very complete, and offered no other striking character for a few moments; then there were occasional backward somersaults, or an effort in this direction. At the second minute, the backward motion began to be seen, as the general spasms and the somersaults ceased. The stupors also appeared, and alternated with the running backward, until within an hour, the animal gradually recovered its usual health."

After witnessing the remarkable result of the production of general convulsions and backward spasms from injury to the spine, below the medulla oblongata, Dr. Mitchell repeated the experiment again and again upon a number of pigeons, with precisely the same results, sometimes obtaining backward somersaults, and at others, only retrograde movements, alternating with periods of stupor and intervals of apparently full control of all the normal movements: he also endeavored to determine by a series of experiments, commencing at the cerebellum, the limits of the region, which being chilled, will give rise to these abnormal motions.

It appears from these experiments, that in pigeons, the application of cold to the cervical spine occasions, after a brief period, peculiar backward movements, resembling those which have been previously produced by mechanical injury of the cerebellum; these abnormal actions are, in extreme cases, backward somersaults, followed by spells of backward walking, and accompanied with spasmodic movements of the head; in milder cases only the backward walking occurs, (both of these forms of constrained movement are met with when the cerebellum has been chilled); on the other hand when the cold is applied to the spinal cord, at or about the fourteenth vertebra, counting from above downwards, the backward spasms and stupors are not produced, and only weakness, violent tetanic spasms of legs and tail, and tetanic rigidity in the legs, coming on some time after the freezing, and reaching a maximum in ten minutes, are observed. The real seat of the backward impulses in birds would seem to be at any point, from the lowest cervical vertebra up to the cerebrum, whose power to originate them is at least doubtful. Two facts, or two sets of facts, led Dr. Mitchell to think it possible, that it was in every case the cerebellum or the medulla oblongata which was the organ finally responsible for the production of the spasms of retrograde motion. The first of these facts is the well known and valuable discovery by Brown-Séquard, that in Guinea-pigs, mechanical injury of certain regions of the spinal cord, from the seventh dorsal to the third lumbar vertebra, subjected the animal to fits of an epileptiform nature, which might be induced by various means, or might arise spontaneously. Moreover, these spasms began about the face, so that the spinal wound, (partial section), must have produced an over-excitable condition of the nerve-centres above the point of injury. In

Dr. Mitchell's experiments, likewise, the spasms began with a flexing of the neck, so hat it is altogether possible that in these animals also, the spinal irritation may act by ausing an undue excitability of organs within the skull. The second set of facts which nade Dr. Mitchell hesitate in assigning to the point of the spine injured by the cold he entire responsibility of producing the retrograde spasms, were the backward somer-aults and violent movements, sometimes continuing for days after certain deep injuries of the cerebellum, as observed by Magendie and other physiologists. The spasms aused by cold applied to the spine, were also of this retrograde nature, and we are therefore furnished, by this comparison, with an additional motive for suspecting that they might really be due to a reflex affection of the cerebellum.

After making a large number of experiments to determine the relation between the backward spasms, originating in mechanical injury of the cerebellum, and those due to chilling of the spine, Dr. Mitchell could not attribute the spasms from cold to the spine alone, but felt strongly inclined to regard this organ as merely the point of departure of a morbid excitation, which is finally translated, so to speak, by the cerebellum into a language of its own, and thus occasions a peculiar form of compulsory movement. This view is still farther strengthened by the state of stupor to which the animal becomes liable when cold is applied to the spine; for it is plain that this is a state of system in which the cerebrum is affected, and for a time loses its functional activity. If, therefore, chilling the spine determines a marked cerebral disturbance, there is no reason why we might not assume, with logical propriety that the cerebellum may be ultimately responsible for the backward spasms.

Dr. Mitchell terminated his important inquiry by experiments designed to *determine the nature* of the injury done to the spine or brain, by cold applied through the skin or directly. It was seen throughout his experiments, which reached ninety in number, that in almost every case an appreciable interval—and often a long one—existed between the close of the freezing and the access of the spasm. This period varied from a few seconds to twelve minutes. If there was any primary effect it was merely feebleness or disorder of movement. It was suspected at once that what is seen on the skin after freezing repeats itself in the nerve substance. First, there is chilling and contraction of the blood-vessels, and then actual freezing, which is rarely very deep; indeed, it is most difficult to freeze the pigeon's entire breadth of spine; when this does occur in the upper cervical region, death by apnoea follows at once.

The freezing being over, the part thaws, and long-continued, intense congestion ensues, as any one may observe who will try the effect of the rhigoline or ether douche on his own skin.

To determine whether the congestion actually took place in the nerve-substance, Dr. Mitchell laid bare the cerebellum of a large pigeon, and carefully noted the color of its tissue, and the number and position of the chief vessels of the meninges. The jet of rhigoline was then used directly upon the part. The visible vessels were instantly frozen, with their contents. As the part thawed, it became intensely congested, the brain darkening distinctly, and the vessels of its transparent coverings increasing in size and number, so that those which could before be seen were larger, and new ones previously unseen, came into view. This experiment was repeated several times, with no essentially different result. After the careful removal of the membranes, the bare cerebellum protected with thin caoutchouc was chilled. As it thawed, an intense congestion appeared, with numerous points of much deeper color. This condition increased during several minutes, but caused no notable disturbance of function. Similar appearances were noted in the spine. Dr. Mitchell concluded, that the singular convulsions and stupors which he had described, were due to the palsy of the vessels which have been chilled by the cold, and which may or may not have undergone previous extreme contraction; the congestion from cold, whether in the nerve tissue or the skin, is most intense at a certain time after the part has been thawed, and it is then in the centres that the excitation becomes such as to determine a convulsive attack.

According to this view, the *congestion* must be regarded as the *essential parent of the nerve changes*, which finally result in the spasm or stupor.

We should not lose sight, however, of the possibility of the nerve substance being itself directly altered by the intense cold, to which it is subjected; for the nerve cells may be most seriously affected during the physical changes of condition, which great alterations of temperature occasion.

In order still farther to elucidate the relations of the congestion to the abnormal phenomena, Dr. Mitchell instituted numerous experiments, and finally succeeded in causing by irritants, spinal congestion and backward spasms; that is to say, the same train of symptoms which succeeded the use of cold. The Tincture of Capsicum gave the most striking results.

It thus appears from these experiments, that the backward movement and convulsive affections and stupor may be excited by agents, which like Tincture of Capsicum, irritate, congest, and perhaps by virtue of the alcohol, chemically alter the spinal tissue; it is also worthy of note, that as in spasms from cold, in like manner in those caused by an irritant, attacks appear only after an interval has elapsed, and are therefore not due to primary alterative influences, chemical or physical.

The following conclusions may be drawn from the preceding facts:

1st. In Traumatic Tetanus the blood-vessels of the cerebellum, medulla oblongata and spinal cord are dilated and congested.

2d. It is possible by cold and irritants applied directly to the cerebellum, medulla oblongata and superior portion of the spinal cord, to produce dilatation and congestion of the blood-vessels; and the congestion thus produced, is attended with exalted and aberrated action of the gray cells, increased reflex action of the spinal axis, and spasms of the voluntary muscles, resembling the abnormal nervous actions characteristic of Traumatic Tetanus.

3d. When the dilatation and congestion of the blood-vessels of the cerebellum and spinal axis, characteristic of Traumatic Tetanus, are examined by the light of careful physiological experiments, they appear to be dependent upon some arrest or alteration of the nervous influence supplied to the unstriped muscular fibre of the minute arteries leading to dilatation of their diameters, and enfeeblement if not complete arrest of the normal peristaltic actions. The gray cells of the cerebellum, medulla oblongata and spinal cord are thus supplied in Traumatic Tetanus, with an increased and abnormal amount of blood, even when there is no increase in the force or frequency of the heart's action.

4th. The sympathetic nervous system which regulates the circulation of the blood in the minute arteries, appears to be involved in Traumatic Tetanus as well as the cerebro-spinal system.

5th. Whilst it is difficult to determine the exact relationship of the disturbances in the two systems of nerves, viz: whether the irrritation is reflected from the wounded surface first to the ganglionic cells of the cerebro-spinal system, and secondarily to those of the sympathetic in the spinal axis, as well as in the ganglia of organic life, in virtue of the intimate relationship of the two systems, and in virtue of the dependence of the lesser upon the greater for a continuous supply of nerve force? or whether the influence affects primarily the ganglionic cells of the entire sympathetic system?—at the same time we may deduce from such facts important therapeutic principles, which will be discussed more fully hereafter, in a separate section of this inquiry. It would appear that after the establishment of the state of increased functional activity in the ganglionic cells of the spinal axis, there is at least an enfeeblement of the sympathetic system, and especially that portion which presides over the circulation of the central ganglionic masses; and the question arises, whether this impairment of its normal functions be due to a diversion of the nervous force ordinarily received by the sympathetic from the cerebro-spinal system? The question also, as to whether the condition of the nervous system preceding the reception of a wound, may have some influence in the production of the disease, although of great interest, cannot as yet be determined with accuracy; the facts bearing upon this question will, in like manner, receive special investigation in a distinct division of the inquiry.

In connection with the preceding facts and conclusions, it is important that we should examine the results of the labors of pathologists, with reference to the structural alterations discovered after death from the disease under consideration.

We have looked in vain through the writings of the older physicians, as Hippocrates, Galen, Aretæus, Celsus, Paulus, Ægineta, Aëtius, Rhases and others, for any facts illustrating the pathology of Tetanus.

Mr. Curling remarks with truth, that,

> "Notwithstanding the labor and attention which have been assiduously directed to pathological investigations of late years, both in this country and on the continent, such researches have, as yet, effected little in elucidating the nature of Tetanus.
>
> "Those writers who have recorded morbid appearances, in the inferences drawn from them, have, for the most part, taken but a partial and confined view, too often attributing the disease in general, to morbid action in such structure or organ, as in the particular case or cases, the subjects of their examination happened to be in some degree deranged.
>
> "In many instances, conclusions have been formed, when the inquiries have been much too limited; for, not only is it essential to examine minutely the brain and spinal cord, but the investigation cannot be considered complete, until the sympathetic system, and the whole alimentary canal have been accurately inspected, and the nerves traced from the seat of injury to their apparent origin. The execution of this necessitates much time, and no slight degree of labor, and when the task is accomplished, the results can only be rightly estimated by one conversant with pathological pursuits." Treatise on Tetanus, p. 29.

The first record of a trust-worthy post-mortem examination in this disease, with which we are acquainted, is found in the writings of John Baptist Morgagni, and is as follows:

Case 23: Traumatic Tetanus.

> "A young man, of two and twenty years of age, having the wheel of a cart pass over almost the lower part of the left heel, seemed to have receied no other disadvantage from it but this, that the common integuments were torn away. While the cure of an injury which appeared slight, went on very well, behold! after some days, the neck and the back became rigid; so that, as if he had been seized with a kind of Tetanus, he could move his limbs, indeed, but could not move either his neck or his back. To this was added, that, at intervals, he was shaken by the most violent tremors of the whole body. And all these symptoms going on in this manner for twenty days or more, his senses being always perfect, he having thrown up a round worm, by vomiting, and the stertor being much increased, he died.
>
> The foot being examined about the evening of that very day on which he died, the heel was found to be almost healed.
>
> The abdomen, which was turgid, being opened, a small quantity of water was seen to be extravasated therein; all the intestines and the stomach itself being sound, but distended with air to a very great degree. Within the colon, near to the appendicula vermiformis, was a round worm, dead.
>
> The thorax also had a small quantity of water effused in its left cavity; the lungs of that side were hard posteriorly, and of a substance like that of the liver. There were polypous concretions in the large vessels, and in the ventricles of the heart; in the right of which cavities, there was blood also, together with airy bubbles.
>
> Upon opening the cranium, in the right lateral sinus of the dura-mater was coagulated blood; in the other was seen a fluid blood, not without some pretty large bubbles. There were many bubbles, also, under the pia-mater, especially about the left anterior lobe of the cranium. Under the same membrane was water besides; the taste of which water seemed to one who was willing to taste it, nothing at all, or at least nothing more than a slight saltiness.
>
> In the ventricles of the brain was a pretty large quantity of water. And no small quantity was discharged from the tube of the vertebræ, especially when I ordered the loins and the os sacrum to be raised up. The cerebellum was lax, the cerebrum firm; and the sanguriferous vessels, that crept through the ventricles of the cerebellum, and the plexus choroides, were not at all of a white color." *The Seats and Causes of Diseases.* London, 1769; Vol. iii, pp. 237–238.

The author of "Recherches et Observations Pathologiques sur le Spinitis, ou Inflammation de la Moelle Épinière, faites a L'Hotel-Dieu de Marseille," published in 1820, under the auspices of the Professors of the Faculty of Medicine of Montpellier, advanced the view that both Tetanus and Epilepsy were due to, or dependent upon, an *inflammation of the spinal marrow*. The proposition with reference to the first disease was sustained by two cases, furnished by M. le Docteur Ducros; the first of which was evidently idiopathic, and the second Traumatic Tetanus.

The following outlines contain the main points of interest in these two cases:

Case 24:- Idiopathic Tetanus.

Joseph Toy, age 19, of strong constitution, waiter in coffee house; 29th September, 1818, after severe exertions, which caused profuse perspiration, exposed himself to cold air. The sudden exposure to the cold air, and the consequent check of perspiration, was followed by violent chills, and pain, and spasmodic contractions of the muscles of the jaw, back, abdomen and chest. The pain was severest about the ensiform cartilage. The next day the young man attempted to resume his occupation, but the difficulty of deglutition and speech, together with the spasmodic contractions of the muscles, compelled him to keep his bed, on the 3d of October. On the 4th of October, he was transported to the Hotel Dieu. On the 4th of October, the patient presented the following symptoms: Jaws firmly locked, head immovable and inclined backwards; permanent rigidity of the muscles of the posterior portion of the neck, back and abdomen; obstinate insomnia; pain in region of xiphoid cartilage; anorexia; tongue somewhat furred; bowels constipated; respiration irregular and spasmodic; pulse hard and frequent; perspiration not abundant.

These symptoms increased in intensity, and were attended by sudden clonic spasms of the muscles of the trunk, followed by violent pain in the back and neck; also, by violent spasms, which were provoked by the slightest movement or noise.

Venesection was fully practiced, but without any apparent good effect. The perspiration became abundant on the 7th day, and urine scant. On the 9th of October (10th day of disease) the spasms were so severe that the patient rests only on the heels and back of the head. October 10th, eyes fixed and projecting; spasms, constipation and interrupted respiration; subsultus tendinum; skin hot. During the night of October 10th, emesis and catharsis were induced by antimonial ptisan. Skin hot; urinary excretion suppressed.

October 11th, (12th day), miliary eruption over the whole surface of the body; eyes immovable; spasmodic contraction of the angles of the lips; respiration difficult and impeded. During the night the patient experienced a violent convulsion, and died a few moments after.

Autopsy; External Appearance: Abdomen tense; skin shows the impressions of the pimples which covered the whole surface; extreme rigidity of the muscles of the neck, chest and back; cellular tissue beneath the skin reddened and congested with sanguineous infiltrations; these changes greatest over muscles of neck and back.

Vertebral Canal: Engorgement, congestion, and sanguineous infiltration of the cellular tissue enveloping the neurilemma of the spinal marrow; veins of membranes of spinal cord congested. Traces of inflammation are most marked about the superior portion of the spinal marrow, in the region of the first cervical vertebræ, and the inferior portion of the lumbar. Serous membrane of the cord more inflamed than the neurilemma, which presents a purplish color; serous effusion, and *false membranes* in the intervals of the nervous trunks composing the cauda equina.

Chest and Abdomen: Traces of phlogosis upon superior surface of diaphragm and upon surface of heart.

Case 25: Traumatic Tetanus, following after the extirpation of a small, Cancerous Tumor.

Pierre Fournier, age 56 years, admitted into the Hotel Dieu, of Marseilles, with a cancerous ulcer occupying the right commissure of the inferior lip, which had made rapid progress, and invaded the neighboring parts. Arsenical paste was applied without success; the diseased parts were then incised, and the lips of the wound united by the twisted suture. The wound appeared to be healing, but the patient removed the dressing; the needles were drawn out, and the edges of the wound pulled asunder. As soon as the considerable inflammation which followed the operation, had subsided, the lips of the wound were again united by the interrupted suture. On the 2d day after the last operation, violent pains were felt in the cervical region, and were accompanied by violent and convulsive contractions of the masseter and temporal muscles, and the fever, which had been abated during the first day, augmented, and was attended by paroxysms; the muscles of the abdomen became hard and contracted. The muscular spasms became general, and the life of the patient was continually threatened by suffocation. Venesections, opium, camphor and musk were tried, but without any appre

> ciable effect. So the superficial muscles were affected one by one, the contraction being most marked in the flexors.
>
> The stitches of the suture were torn apart by the violence of the spasms, and on the 3d day the needles had been completely torn out of the lips of the wound. The contraction of the muscles and the retraction of the lips of the wound, gave the patient a horrid expression. The free and continued use of opium, musk and camphor, ameliorated somewhat the symptoms, and appeared to prevent the destruction of the patient by suffocation, which for several days was imminent. The muscles which had been affected the first day, became less contracted, the patient could open the mouth and execute a few movements with the head; the constipation ceased, and the abdominal parietes became less rigid. Nevertheless, the dorsal muscles and thoracic muscles remained rigid, and the difficulty of respiration continued extreme. The patient, enfeebled by the continued and abundant loss of saliva, by the difficulty of swallowing, and by the continued spasms, and enfeebled and embarrassed respiration, and by the intense pain, died on the 23d day after the invasion of the Tetanus.
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> *Autopsy Three Hours After Death:* The examination of the cranial, thoracic and abdominal cavities revealed nothing abnormal.
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> When the spinal canal was opened, a whitish, serous effusion was found between the marrow and its envelopes. The surface of the spinal marrow and of the arachnoid membrane was covered by a soft substance of the same color with serum (coagulable lymph), This effused matter was denser towards the lumbar region, and was mixed with false membrane. This matter was denser, and of a lardacions character in the lumbar region, and contained a greater proportion of false membrane, which united in one mass the larger nervous trunks given off from the lumbar portion of the spine.

The author of the Researches on Spinitis, concludes that the Idiopathic Tetanus, so common in warm climates, was similar in its patholgy with Tetanus arising from wounds and injuries, both being dependent upon "*inflammation of the spinal marrow.*" "The profound alteration in the actions of the muscles, which characterizes Tetanus, cannot be explained without admitting that the centre, whence the nerves spring which go to the muscles of animal life, is itself affected." * * "The fatality of Tetanus can only be explained by the importance of the organ (spinal marrow) which is its seat."—*Recherches, etc.*, pp. 41–50.

The testimony of Carl Rokitansky, with reference to the condition of the cerebrospinal nervous system, after death from Traumatic Tetanus, as contained in his Manual of Pathological Anatomy, is not so clear as in many other diseases, the pathological lesions of which have been so fully illustrated by his extraordinary labors. Thus, under the head of Diseases of Texture of the Spinal Cord, Rokitansky remarks:

> "Congestion of the spinal cord is a spmptom in the course and sequel of sundry acute an-chronic diseases. Such, most probably, is its real import, in those who have died of Tetanus, convulsions and hydrophobia. It is almost constantly met with in those cases, combined with an equal degree of congestion of the brain."

When describing the diseases of the texture of the nerves, this pathologist calls special attention to the following condition of the nerves in cases of Traumatic Tetanus, which he affirms to be the only real fact which has been made out in such cases after death:

> "Froriep has ascertained, that, besides the inflammation which is seen in the nerve at the spot which has been injured, a rosy red is produced at irregular intervals in its course, by the injection of its neurilemma, but it is unaccompanied by any distinguishable products. The reddening is most confined to the surface of the nerve, though it sometimes dips a little way between the fasciculi. If a plantar nerve, for instance, has been injured, it is repeated three, four, five or more times in the course of the tibial and sciatic nerves, up to the sacral plexus; but neither where these nerves enter the medulla, nor in the cord itself, is any similar appearance to be found."

Rokitansky is evidently in error, when he attributes the discovery of certain changes in the injured nerve in Traumatic Tetanus, to Froriep, whose observations upon seven cases of Tetanus, which had been preceded by injuries of nerves, were published in 1837. Various surgeons and pathologists, both previous and subsequent to Froriep, have recorded similar observations.

Baron Larrey based an important portion of his treatment upon the view that irritation is first set up in the wound, and in the injured nerves. Thus, he says;

> "The first object is to remove causes of irritation, and to re-establish the suppressed excretions. This is to be effected by suitable incisions in the wound made before inflammation takes place, for, should this be much advanced, incisions are useless, and even dangerous: when necessary, they should include as much as possible of the wounded nervous cords and membranes; but incisions at the articulations are injurious, and appear generally to increase the symptoms; I have seen examples of this. Caustic applications to the wound may be made with advantage on the first appearance of the wound; provided the same rule be observed as in case of incisions."

The unexpected and complete success that followed the amputation of a wounded limb of an officer attacked by Chronic Tetanus, induced Baron Larrey to propose the query, whether, in this disease, which arises from a wound in some part of the extremities.

> "Is it not better to amputate the wounded limb as soon as the symptoms of Tetanus appear, than to rely on the uncertain resources of nature and art to affect a cure? * * Amputation of the limb being made on the first appearance of the symptoms, all communication with the origin of the evil is cut off. This operation unloads the vessels, removes the twitchings of the nerves, and convulsive motions of the muscles. The first effects are followed by a general collapse, which promotes the excretions and repose, and re-establishes the equilibrium of the body." * *

After recounting several cases in which Traumatic Tetanus was either cured or greatly relieved by incision of the nerves and amputation of the injured limbs, Baron Larrey affirms,

> "That amputation performed at a proper time, is the most certain means of arresting tetanus, when it is produced by a wound in the extremities."

In one case in which tetanus had supervened and proved fatal after the amputation of the arm, Baron Larrey found that the median nerve was included in the ligature with the humeral artery, and was tumefied below the ligature, so as to resemble a mushroom, it was also much swollen above the ligature, and of a red color. On inspecting the body of another soldier, who had died of this disease, and whose leg had been amputated nineteen days before, Baron Larrey found the nerves enlarged at their extremities, and adhering to the surrounding parts. He affirms, that he had often removed the symptoms of incipient tetanus, by adopting such means as are suited to remove its causes, viz: by cutting the ligature of an artery in which a nerve is included, and to which the patient refers all his pain, and where the nervous irritation takes its rise. This division of the ligature arrested the disease in its forming stage and expedited the cure of the wounds, there being no danger of hæmorrhage if the vital powers be not debilitated;—a few hours of direct compression bringing the walls of an artery into contact, being sufficient to induce adhesive inflammation.

Baron Larrey also records several cases illustrating the cure of Traumatic Tetanus by the application of the actual cautery to the wounded surface, and to the extremities of the injured nerves.

Baron Dupuytren discovered in the arm of a boy who had died of Tetanus a few days after, being struck by a coachman, a portion of a whip enveloped in the very substance of the cubital nerve.

John Hennen, in his Military Surgery, mentions that in one case he found the radial nerve connected with the injury, thickened, and a spiculum of bone sticking in it (p. 251, 3d Ed).

M. C. Pelletier, Chief Surgeon at the Hospital at Mans, is 1826, communicated to the Royal Academy at Paris, a Memoir in which he attempted to show that in all cases Tetanus originates in inflammation, extending from the neurilemma of the nerves of the part injured, to the membranes or substance of the medulla spinalis.

Cases 26 and 27 : Traumatic Tetanus.

In a case where Tetanus occurred after a compound fracture of the humerus, M. Pelletier found the neurilemma of the cubital and median nerves red and inflamed, d also the envelopes of the brain and spinal cord ; and it was remarkable, that the ppearances of inflammatory action were confined to the left side of these membranes, eing the side corresponding with the arm that was fractured. In another case, in which the disease appeared on the seventh day, after an incision made into a carbuncle n the inner part of the left leg, on dissection, forty hours after death, the membranes f the spinal cord were found to be unusually vascular, and the cord itself, from the ourth cervical to the fourth or fifth dorsal vertebra, red and very soft. The branch f the sciatic nerve distributed to the site of the carbuncle, was encircled by a vascuar network.

Case 28 : Traumatic Tetanus.

M. Pelletier also communicated to the Academy of Medicine, the particulars of a third case of fatal Tetanus, supervening upon amputation of the leg. A lad fifteen years of age, and of a feeble constitution, had his left leg removed in consequence of a malignant affection of the heel. He went on very well for three days, and the wound partially healed by the first intention, when he experienced considerable tenderness in the stump, with convulsive twitchings of the muscles. On the sixth day, the patient was attacked with trismus, the respiratory muscles shortly became affected, and notwithstanding he was largely bled, the disease proved fatal on the eighth day, after the amputation. On dissection, a small depôt of purulent matter was discovered in the stump at the head of the fibula, the parts around being inflamed. The sciatic nerve at this place was found softened in structure, and of a violet blue, being much injected with blood, and the appearance was continued for eight or ten inches to the hip, being also observable in some of the branches of the nerve. For some days previous to the accession of tetanic symptoms, the patient had complained of pain in the track of the nerve when it was pressed upon. The pia-mater of the medulla spinalis, at the part corresponding with the origin of those nerves supplying the muscles affected with spasm, was highly injected, reddish effusion was found under the membranes, and the spinal marrow itself, in the middle of the dorsal region, was in a state of ramollissement. Séance, October 12th, 1826 : Révue Médicale, 1827, tom iv, p. 183, Journal de Progres, 1828. Archives Générales de Médecine, tom ii, Second Series, Treatise on Tetanus,by Curling, p. 41.

Case 29 : Traumatic Tetanus.

In the case of a female, 19 years of age, who died of Tetanus, consequent upon a wound in one of her fingers from a splinter of wood, which inflamed, and was followed by the formation of an abscess, it is stated that on inspection of the body by Dr. Hesselbach, in some places the nerve of the arm was remarkably congested, and between the dura-mater and arachnoid was contained a pretty large quantity of bloody serum, the vessels being much injected with extravasation of blood throughout the whole course of the spine. (Glasgow Medical Journal, vol. iii, p. 191).

Case 30 : Traumatic Tetanus.

In the 2d volume of the Glasgow Medical Journal, a case of Tetanus is reported of a boy that was scorched on both legs. After death the nerves were accurately examined. The cutaneous nerves of both legs, particularly the communicans tibialis, the communicating branches of the peroneal nerve with the tibialis communis were inflamed at the seat of injury ; tracing them upwards, above this point, they were perfectly healthy, except that portion of the peroneal which turns over the head of the fibula, there again it was distinctly vascular, thus leaving an intermediate portion perfectly free from the appearances of inflammation. The vascularity seemed to be confined to the sheath of each nerve ; the deep seated branches appeared to be quite natural.

Case 31: Traumatic Tetanus.

In another case reported in the same journal, the patient had the ring and middle finger of the right hand much lacerated and injured by machinery, and the last phalanx of the middle finger being adherent to the second only by a small slip of skin, it was removed accordingly. It was discovered on dissection, after death, that the nerves on each side of the remaining phalanx of the ring finger were very vascular. On tracing upwards the ulnar nerve from this point to the elbow, it was of its natural color; but here again it became very vascular for about the extent of two inches. In the axilla, it again presented a similar appearance to that at the elbow, the portion of it intervening betwixt these two points being healthy.

Tracing the median nerve in the same way as the ulnar, it was found pretty natural from its digital branch which supplied the radial side of the ring finger (and which as stated above, was much inflamed,) to about the middle of the arm, where it again presented an inflamed appearance for the extent of one inch and a half. The portion of it intervening betwixt this point and that confined to the axilla, where it again became vascular, was natural. This vascularity throughout was not confined to the sheaths of the nerves, but occupied their substance; the radial and superficial nerves of the arm, along with its veins and arteries were perfectly natural.—Glasgow Medical Journal.

Cases 32, 33, 34, 35: Traumatic Tetanus.

Mr. Curling, in a case of Traumatic Tetanus, on examining the wound, (after death), at the back part of the thigh, which was inflicted by a spike that had penetrated deeply into the semi-tendinous muscle, driving a piece of wadding before it, found the sciatic nerve which passed close to the bottom of the wound, highly injected with blood.

In another fatal case, Mr. Curling traced the internal plantar nerve to the wound which was occasioned by a compound dislocation of the great toe, where it appeard thickened and its neurilemma unusually vascular, In the dissection of a patient of Mr. Ewbanks, who had died of Tetanus, after a wound of the leg by a pitchfork, the prong was found to have penetrated to the peroneal nerve, which was bruised, and implicated in the inflammation set up in the part. (Treatise on Traumatic Tetanus, p. 39, Medical Gazette, vol. ii, p. 346.

In a case of Traumatic Tetanus following laceration of the hand, which was amputated by Mr. Liston, as soon as the tetanic symptoms made their appearance, the branch of the median nerve going to supply the thumb, was found torn two-thirds across, and its extremity inflamed and thickened for nearly an inch.

Dr. Murray, as quoted by Mr. Curling, has related a case where the wound giving rise to the disease, was a severe laceration of the integuments of the leg, with fracture of the tibia and fibula. When examined after death, the sheath of the popliteal nerve was highly injected with blood, and from the ham downwards, the nerve was remarkably red in all its ramifications in the directions of the fracture, some of them being enlarged. Treatise on Traumatic Tetanus, pp. 39-40.

Cases 36 and 37: Traumatic Tetanus.

In two cases mentioned by Dr. David Craigie, in his *Elements of General and Pathological Anatomy*, in which the injuries were similar, viz: fracture of the middle phalanges of the finger, the symptoms of tetanus came on about three weeks after the infliction of the injury, and proceeded in the course of a few days to a fatal termination.

In both cases the nerve coat connected with the injured part, was reddened, vascular and injected, and manifestly thickened, while the nervous matter of the nerve was reddened, swelled and softened.

In the first of these cases which took place in the person of a young man who had been brought from Musselburgh to the Edinburgh Royal Infirmary, Dr. Craigie examined the whole spinal cord with care. He found it quite sound, except in the cervical portion where the envelopes were reddened, and had evidently been the seat of inflammatory injection. Beneath these envelopes, the spinal cord, in the cervical portion was reddened and softened for the space of between one inch and a half and two inches. So far as he could determine, this was the point which gives origin to, or is connected with those branches of the cervical nerves, which proceed to, and chiefly form the brachial plexus. In this case, therefore, Dr Craigie inferred that the injury done the finger, and the subsequent inflammation, especially of the digital nerve, and its nerve coat had been reflected, as it were, to the spinal origins of these nerves, and thus induced inflammation and irritation of the spinal marrow then softening; and that these were the efficient causes of the tetanic symptoms and their fatal termination.

In the second case in which the patient died under the care of Dr. Paterson, of Leith, the

ends of the nerve were red and softened, and its tunic in like manner red, injected
tened; and in the same manner, on inspecting the spinal marrow, a portion of that
the cervical region, no less than two inches in length, very distinctly reddened and
indeed quite creamy, while the rest of the cord was firm and of normal consistence.
thus affected with softening, corresponded very accurately with the origins or spinal
ons of the cervical nerves, which contribute to form the brachial plexus.

raigie* affirms that he had repeatedly seen the nerve or nerves of parts injured
used in Tetanic cases presenting redness, vascularity, thickening of the neuri-
nd softening of the nerve, but he had not had opportunities of examining the
rd in any other case.
w of the preceding cases (36 and 37), Dr. Craigie expressed his belief, that
natic Tetanus, the irritation is propagated from the injured parts in the reflex
, to the spinal connection of the nerves; that there it is followed by another
, and by inflammation of the spinal marrow; and that the last is the cause of
nic symptoms. This further seems most probable, when we consider that some
ways elapses between the date of the infliction of the injury, and that of the
ymptoms; that is to say, the establishment of the inflammatory irritation of
al marrow.
us abnormal appearances and lesions in some part of the brain, spinal cord, or
sting membranes have been recognized and recorded by various pathologists, as
s, Larrey, Magendie, Recamier, Professor Frank Brera, Dr. Reid, Dr. Kenedy,
gie, Mr. Clarke, Dr. Aitken, and others; and inflammation in these textures
viewed by several writers as the cause of tetanus.
Larrey states, that in the numerous inspections of the bodies of the soldiers
of Tetanus in the hospital of Louvain, after the battle of Waterloo, which
de with the greatest care, "he constantly discovered evident traces of inflam-
n the spinal cord, with serous effusion more or less of a reddish color within
th." *Clinique Chirurgicale*, tom i, p. 88. "Unequivocal marks of inflam-
in the medulla spinalis and investing membrane, have been observed by Mr.
an Army Veterinary Surgeon, (London Medical and Physical Journal, Vol. iv,

ding to Dr. James Copland,

spinal cord, medulla oblongata, brain, and their membranes, have frequently pre-
anges, more or less decidedly morbid in tetanus and trismus. I believe that these
are rarely altogether absent, especially as respects the spinal cord, medulla oblongata,
varolii and their membranes, when the inspection is made within twenty-four hours
th, and when these parts are carefully examined. * * The changes more com-
served, are vascular injection of the pia-mater, sometimes with exudations of lymph
e surface; hardening or softening of one or more of the columns of the cord, or of
lla oblongata, softening being more frequently observed when the inspection has
g delayed; opacity of the arahnoid, or deposits of small plates of bone or of car-
the free arachnoid, the surface of those plates, being rough on the sides next
pia-mater; generally increased vascularity sometimes with recent adhesions, and
ons of the veins and venous sinuses of the spine. These changes may extend
less generally along the cord and medulla oblongata, often also to the pons
and even to parts in the vicinity of the latter, and surrounding the fourth
e. They were thus observed with several ossific plates in the arachnoid, in an
ase of tetanus, which was under my care in 1820, and of these appearances I
colored drawing, which is still in my possession. In addition to these, the sub-
of the cord and medulla is somewhat reddened or injected, and exhibits numerous
its when divided. In some cases, the membranes are more decidedly inflamed
kened, generally the spinal fluid is abundant and somewhat altered or turbid. In
tances, a puriform exudation is found between the membranes, and the softening of
n of the cord presents a puriform infiltration, with capillary injection. In still rarer
e serous exudation is of a rose color, or even more deeply tinged, or even blood is
ated and extended along a considerable part of the cord. Dic Prac. Med., Am. Ed.,
p. 1107."

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nts of General and Pathological Anatomy, Sec. Ed. pp. 385–387.

In a paper published by Dr. Copland, in the London Medical Repository for May, 1822, Dr. Copland suggested that the ganglia and sympathetic nerves were the seat of pathological cause of tetanus, and especially of the idiopathic form of the malady. He contended that the ganglia, or the organic system, is the source of irritability in contractile tissues: and that when this property is inordinately excited, without the control of the will, that changes should be looked for in this system.

Some years subsequently, Mr. Swan directed attention to the sympathetic system in Tetanus, and stated that the ganglia were preternaturally injected in this disease; and appearances said to support this statement, were observed by Andral, Aronssohn, and Dupuy; while Meyer, Vetter, Bright, and others, have adduced instances of tetanus consequent upon ossific deposits irritating branches of ganglionic nerves.

In two cases, Mr. Curling found the cervical ganglia of the sympathetic unusually vascular, whereas in a third instance, they were natural: M. Dupuy states, that he has frequently discovered disorganization of these ganglia, and of other nervous trunks in horses that have died of Tetanus. In Ploucquet's Literatura Medica Digesta, a case is referred to by Meyer, in which Tetanus is supposed to have been induced by an ossification of the pleura, irritating the splanchnic nerve. In the same work, there is likewise an allusion to a case from Vetter, in which irritation of the par-vagum, from the sharp point of an ossified gland, in the vicinity of the trachea, was supposed to have given rise to the disease. Mr. Swan has also shown that the ganglia of the sympathetic nerves are rendered unusually vascular in animals poisoned with gamboge, arsenic, strychnine and mercury, and he has met with these appearances in cases where great constitutional irritation has followed severe injuries. With reference to such observations, Dr. James Copland remarks, that it should not be overlooked, that the ganglia are often very vascular, even in health; that they are not always, or even generally, usually or excessively vascular, and much less manifestly inflamed in Tetanus; and even granting them to be excessively injected or inflamed, it cannot be shown that their inflammation could be more productive of tetanus, than a state of irritation or of vascular erythism, this latter condition being manifestly more compatible with excessive discharge of function than a state of inflammation.

In some of the cases reported as Tetanus, it is evident that the disease has been confounded with cerebro-spinal menengitis. Thus in a case which occurred at Udina, and which was at the time brought forward to show that tetanus "is inflammation of the spinal cord," and as confirming Mr. Bell's idea, that movement depends on the anterior, and sensation on the posterior roots of the spinal nerves, the disease arose in a woman, without any external injury, and as the consequence of over-exertion and cold. On examination after death, the brain was found in a healthy state; the vertebral canal was filled with a bloody serum; the anterior portion of the spinal cord was of a yellowish dirty white color, and covered with small round and oval bodies, decribed as hydatids, from the size of a millet seed to that of a pea, which were probably coagulable lymph. The substance of the spinal cord exhibited reddish spots; the posterior part was healthy; the posterior roots of the spinal nerves had a very different appearance from the anterior roots; the latter were evidently softened, and presented a yellow color; the former were perfectly healthy. Annali Univ. di Milano, London Lancet, Vol. i, 1828–9, p. 135.

In two cases of Traumatic Tetanus reported by Dr. Parry, in the Glasgow Medical Journal, February, 1831, morbid appearances, irregular congestions, and "inflammation at the seat of injury," were observed in the nerves connected with the injured parts. In one case, a considerable quantity of partly fluid and partly coagulated blood, existed between the theca and the vertebræ, and both lobes of the cerebellum presented a congested and ecchymosed appearance.

Case 38: Traumatic Tetanus.

In a case of Traumatic Tetanus, terminating fatally in Westminster Hospital, ten days after the manifestation of Tetanic symptoms, which appeared ten days after the foot of the lad had been pierced by a nail, the following alterations were observed in the brain and spinal cord;

"Immediately after death, the body was placed prone, to prevent the gravitation of the blood towards the spine. Twenty hours after the demise of the patient, he was laid on a dissecting table, and his spine was opened. There was slight sanguineous extravasation between the bony sides of the vertebral canal and the theca vertebralis. On opening the theca, a serous effusion was discovered, so copious in the sacral parts of the spine, as to produce compression. There was also a considerable quantity of serum in the cervical portion of the theca; the spinous arteries and their filaments were injected.

In the cranium, the brain and its meninges were more than naturally distended with blood, and in each lateral ventricle, half an ounce of a pink-colored serum was found; the velum interpositum and choroid plexus were also universally turgid. There was no evidence of disease in any of the other viscera." London Lancet Vol 1, 1831-1832, p. 715.

Case 39.—Traumatic Tetanus.

Another case, occurring in Westminster Hospital, yielded somewhat similar results. The disease was caused by a contusion and laceration of the index finger of the left hand. The patient, a lad, was treated by Mr. Guthrie:

The day after death, the body was opened in the presence of Mr. Guthrie and several medical men. As soon as the breath was out, the body had been placed prone, with a view of preventing the gravitation of the blood or other fluids towards the spinal cord. In the brain, the pia-mater was found injected, and a cosiderable deposition of lymph was discovered between the pia-mater and tunica arachnoidea. All the sinuses and veins of the brain were gorged with blood. There was no fluid in the ventricles, but the plexuses of the velum interpositum were excessively distended. In the theca vertebralis a large quantity of dark, extravasated blood was found. The pia-mater of the medulla oblongata and of the spinal cord was much injected, and this heightened color of the membrane was traceable for a considerable distance in the neurilemma of each spinal nerve. London Lancet, Vol. 1. 1833-1834, p. 389.

Case 40: Traumatic Tetanus.

Dr. William Wallace describes the nerve leading to an injury in the right leg inducing Traumatic Tetanus, as inflamed and thickened in the immediate neighborhood of the injury; a quantity of a serous bloody fluid existed in the cavity of the arachnoid. The vessels of the membranes of the cerebrum, cerebellum, medulla spinalis and oblongata were very turgid. Great effusion between the pia-mater and arachnoid—particularly on the superior surface of the hemispheres. An effusion of blood on the outside of the sheath of the spinal marrow, nearly opposite to the middle of the chest. The plexus choroides livid from congestion; some reddish serum in the ventricle; the substance of the brain very firm and over-vascular. London Lancet, 1835-1836, Vol. 1, p. 847.

Case 41: Traumatic Tetanus.

A "highly inflamed state" of the covering of the anterior crural nerve, and of its superficial and deep-seated branches, was observed by Mr. Richard Britohistle, in a case of Traumatic Tetanus, following a gun-shot wound of leg. London Lancet, 1836-37, Vol. 1, p. 298.

Case 42: Traumatic Tetanus.

At the autopsy of a patient who died in the Hotel Dieu, of Paris, with Tetanus supervening on fracture of the leg. numerous ecchymoses were found in the fibrous sheath of the spinal cord; and external to that membrane a collection of black and liquid blood occupied the lower part of the vertebral canal to the height of five or six inches. The spinal cord itself was softened througout its lower two-thirds, and closely adherent to its pia-mater; and the ramollissement continued, though in a less degree, to the occipital foramen, terminating just below the corpora pyramidalia.

Within the cranium, the pia-mater was observed to be greatly injected, and there was extensive softening of the left anterior and middle lobes of the brain. In the sciatic nerve of the right side, (the side of the fracture), ecchymoses and inflammation were perceptible, but there was neither in the nerve of the opposite side. Archiv. de la Med., April, 1843. London Lancet, 1842-33, Vol. ii, p. 508, July 8th, 1843.

Case 43: Traumatic Tetanus.

In an interesting case of Tetanus, given by Dr. Reid, in the "Transactions of the Association of Physicians in Ireland," Vol. i, p. 113, great vascularity, and an effusion of blood were found round the spinal marrow.

Case 44: Traumatic Tetanus.

In another case detailed by Mr. Brayne, of Banbury, in the "London Medical Repository," Vol. xiv, p. 1, two or three inches of the inferior dorsal portion of the spinal marrow, were suffused by a continuous blush of inflammation, and three small, hard, white laminæ were seen between the arachnoid and pia-mater.

Case 45: Traumatic Tetanus.

The post-mortem examination of the body of a man aged 70, who died from Traumatic Tetanus, occurring one month subsequent to the reception of an extensive lacerated wound of the integuments of the fore-arm, performed in Guy's Hospital, by Dr. Hodgkin, revealed softening of the gray matter throughout the greater part of the cervical portion of the spinal medulla. The softening was more particularly observed in the right lateral medulla. London Lancet, November 24th, 1827, p. 325.

In 62 deaths occurring in Guy's Hospital, from Tetanus, during a period of thirty-two years, from 1825 to 1857, 18 were not examined, and of the remaining 44, in only 34 were inspections recorded. The brain was examined in 20 cases; in 11 it was healthy and firm, with nothing morbid in color or consistence; in 9 it was congested, darker than natural, dark and flabby, pinkish, with ulcerations on under surface of anterior lobes, and decomposed. The spinal cord was examined in 19 cases; in a few it was redder than natural, congested and softened, but in the greater number nothing abnormal was recorded. The condition of the nerves at the seat of the wound was noted in 14 cases; in five they were inflamed. The heart was violently contracted in only one case; and in this, the patient died on the second day, from suffocation, after laryngotomy had been performed for his relief. In 28 cases, in which the condition of the lungs is given, in 7 they were congested, in 3 pneumonic, and in 4 apoplectic. The larynx, in one case, in which the patient died in a paroxysm, was found closed by the epiglotidean folds being caught in the rima. Nothing of special importance was noted in the condition of the other organs of the body. Out of 7 cases, there was unusual post-mortem rigidity in 6, and in one case this was observed, five hours after death, and in another fifty. (Guy's Hospital Reports, 3d Series, Vol. iii; Am. Jour. Med. Sci., Oct., 1858; Brit. and Foreign Med. Chir. Rev., April, 1858.)

Mr. Benjamin Travers, whilst holding that "the evidence before the public to establish that Tetanus has its origin in inflammation of nervous structure, has failed;" and that "even the common statement of increased vascularity and effusion beneath the investing membranes, are as common in other acute diseases as in this, and they are by no means universal in Tetanus," nevertheless, records several cases occurring in his own practice, which illustrate the fact that the disease is characterized by certain lesions of the spinal axis. Thus, in a fatal case (46) of Tetanus occurring Dec., 1820, in a porter, after fracture and amputation of the middle finger,

> "On examination, half an ounce of reddish serum issued from the spinal canal, and the medulla spinalis was pulpy."

In another case (47), caused by compound fracture of the right leg, (Oct., 1822),

> "The vessels," of the brain, "were turgid, and a considerable effusion of serum was found between the opaque arachnoid, and the pia-mater; the membranes of the cord presented universal vascularity."

In the Case (48), of a lad, March, 1828, "some effusion under the arachnoid, and general increased vascularity of the cerebral and spinal membranes."

Case 49: Traumatic Tetanus.

In a case of violent tetanic spasms, which supervened two days after a blow on the cervical spine, and which proved fatal in twenty-four hours, the cervical portion of the spinal cord

> was softened to the extent of an inch, whilst the membranes of the spinal cord were inflamed and thickened.

In his "Further Inquiry on Constitutional Irritation," Mr. Travers records only a single post-mortem in this disease, in which no special lesions of the cerebro-spinal system were observed. He says that after the occurrence of a certain case of Tetanus in Guy's Hospital, in which he observed, after death, that the arachnoid coat of the brain was raised in pouches by an unusual quantity of serous fluid, and that the ventricles were fuller than natural,

> "It became the custom to inspect the spine in every case of death from Tetanus; and in five out of eight, some morbid disposition was discovered in the substance of the arachnoid tunic covering the medulla. With one exception, they presented the appearance of distinct osseous patches, chiefly on the lower part of the cord, or cauda equina, so brittle as to crackle on pressure, and of the thinness of silver paper. In the exception referred to, the deposit had a cartilaginous appearance." Further Inquiry, pp. 299, 314, 318, 320, 321.

John Hennen made few, if any, post-mortem examinations of the brain and spinal cord in Traumatic Tetanus, as is evident from the following observations upon the pathology of this disease, contained in his Military Surgery, (Third Ed., London, 1829, pp. 252, 253.

> "The host of authorities referred to by Plouquet, and indeed all other authorities upon Tetanus, lose much of their interest if unaccompanied by dissections. Some recent occurrences, and particularly a case detailed by my friend, Mr. Webster, Surgeon of the 51st Regiment, in the Medico-Chirurgical Journal, for October, 1817, have determined me to lose no opportunity of minutely examining the spinal cord and the theca vertebralis, in all future cases of acute Tetanus, or of a disease in many points very analogous to it,—hydrophobia; a determination in which I am strengthened by the opinion of the author of the excellent paper in the Medico-Chirurgical Transactions above referred to. I have already had many communications on the subject, and while some of my informants assert that they have found the vessels of the spinal marrow in a state of congestion, others, of equal accuracy, assure me that they could detect no change whatever upon them. From some of my correspondents, I have obtained information, by which I am perfectly satisfied that some of the changes described as morbid, were natural to the parts, and that others were the consequence of a rude use of the saw and chisel. The point, therefore, may be considered as requiring much more accurate observations, and more accurate dissections than have hitherto been made; although of the frequent existence of congestions in the vessels of the spine, and of consequent effusion into the canal in tetanic cases, there can be no rational doubt."

Traces of inflammation and congestion about the brain and spinal marrow were observed in a case of Traumatic Tetanus, resulting from injury of the fingers of a young man aged twenty-seven, recorded in Guy's Hospital Reports, April, 1844.

W. W. Valk, M. D., has recorded the appearance presented by the spinal cord in two cases of Tetanus, as follows:

Case 50: Traumatic Tetanus.

> Mary Henson, æt. 14; died on the fifth day from the accession of tetanic symptoms; her body was examined nine hours after death. With some difficulty the vertebral canal was laid open from the cervix to the sacrum. To judge from *appearances*, active inflammation had existed upon its investing membrane, the vessels of the pia-mater being very *conspicuous, numerous and greatly distended.* Nothing remarkable in the aspect of the tunic arachnoidea, or the medulla. On tearing up the skull cap, much blood escaped from the laceration of the vessels of the dura-mater; the brain being exposed, presented no unusual appearance, nothing indicative of congestion, or extravasation.

Case 51: Traumatic Tetanus.

> Rebecca Peterson, æt. 47; died on the third day of the disease; examined twelve hours after death.
>
> Spinal cord healthy, vessels of pia-mater *much congested*, serous effusion between it and the tunica arachnoidea; no other part examined. Am. Jour. Med. Sci., Vol. ix, 1831, p. 540.

We find the following interesting experiments upon the artificial production of Tetanus in dogs, by the introduction of irritating bodies into the nerves, recorded in some observations on Tetanus, by Dr. W. A. McDowell, published in the New Orleans Medical Journal, Vol. ii, March, 1846, p. 578.

> November 22d, 1840.—Introduced minute tack points into the muscular spinal nerve of dog Gumbo, at the point where the nerve passes over the lower end of the radius; and on the same day, into the ulnar nerve of the dog Watch, at the point at which the nerve passes over the upper head of the os ulna; passing the tacks completely into the nerves, burying both extremities within the theca. The wounds healed kindly, the licking of the dogs preventing the ability to determine whether with or without suppuration.
>
> They fed well, and continued healthy for six weeks.
>
> On the morning of the 5th of January, 1841, Gumbo was found convulsed, with his jaws firmly clenched. Nothing was done in the case until three o'clock P. M., when the whole muscular system had become rigid, respiration difficult, the abdomen retracted, and a bloody-looking sanies flowed from the bowels. In this condition, with the assistance of Dr. Finley, he was trephined, without evincing sensibility to the operation. On compressing the brain with the ball of the thumb, complete relaxation of all the muscles was effected in the course of a few seconds. In about an hour and a half the spasms recurred, when they were again relaxed by the compression, the animal recovering some degree of sensibility during each relaxation; on the next recurrence of the spasm, at nearly six o'clock, an incision was made at the wrist, and the portion of nerve containing the tack, was removed, when the spasms relaxed, and returned no more. This circumstance may, by the by, be attributable to exhaustion. The animal died half after seven o'clock.
>
> The second dog, Watch, became affected three days after Gumbo's decease, with irregular spasms; these increased as the day advanced, and in the morning he appeared unusually uneasy and restless; the following morning he was missing, and has never since been heard of.

Such experiments strongly support the view that Tetanus has its origin in local irritation of the nerves. Mr. Poland has shown that lacerated wounds are much more frequently attacked with Tetanus than incised wounds; thus, at Guy's Hospital, the disease occurred only in one case out of 1364, where the wound was made by a sharp knife, but it ensued in one out of 55, where the nerves were injured, as in accidents.

Cases have been recorded in which the spasms were almost entirely limited to the side injured. Three cases recorded by Langenbeck, sustain the view that Tetanus, in its origin, may be dependent on local irritation; in the first, the removal, by an incision of a fragment of a needle, was attended by an immediate subsidence of the symptoms, and the recovery of the patient; (Syd. Soc. Year Book, 1863, p. 220); the removal of a ligature, which had been tied *en masse*, after castration, at once stopped all the symptoms in the second case; and in the third case, the reduction of a fracture which was attended with great displacement, had the desired effect. Hasse states that very frequently the lodgment of splinters of bone, or the like, among the tissues, has decidedly influenced the development of Tetanus; and Mr. Erichson says, that he has never failed to find the nerve running from the wound more or less inflamed, and often for a considerable distance, whenever it has been looked for. Dr. Packard, of Philadelphia, found fatty degeneration of the ulnar nerve, in a case of Tetanus, in which the fore-arm was amputated two and one-half inches below the elbow. The Tetanus had been preceded by extensive sloughing of the tissues:

> "By the sloughing, was laid bare a portion of the ulnar nerve, which was excised by Dr. Pancoast, with a faint hope of arresting the symptoms. A portion of the excised bit of nerve seemed to the naked eye to be healthy, the rest was abnormally vascular. The former, under the microscope, was proved to be actually in a normal state; the latter was throughout in a condition of well marked fatty degeneration." North Am. Med. and Chir. Review, Jan., 1859, p. 107.

The preceding post-mortem examinations which we have recorded, as well as the observations of Froriep and others, supplied undoubted proofs of the origin of Traumatic Tetanus in nervous irritation, and we have merely introduced these facts as corroborative evidence.

y Sandwith has recorded the following interesting observations on the tanus:

witnessed the post-mortem examinations of the spinal cord in Traumatic which there were traces of hyperæmia in the nervous mass or its mem- ich, though topical depletion of the spinal column was employed, the chief placed on morphia and cathartics. I resolved on the adoption of a more gistic course at the first opportunity. All the three cases alluded to, had ull General Infirmary, and in one of them, Mr. Wallis, (who intends to pub- them, with colored sketches of the medulla spinalis and its investments), nal marrow of the tetanic patient, with that of one who had died the same not involving in any way the nervous centres.

the other tetanic cases, there was increased vascularity of the cellular mem- g the theca-vertebralis, together with increase of fluid, within the theca, well as the substance of the medulla, were extremely vascular. But when s or slices of the spinal marrows of the tetanic and non-tetanic patients ted to a microscope of immense magnifying powers, the greatest difference res became apparent. In that of the tetanic patient, the vascularity was in ernally as internally, in the gray, as well as in the medullary matter. The on-tetanic patient was not only without signs of marked vascularity, granular appearance; whereas, that of the tetanic, on the contrary, r or reticular aspect, and looked softer and more spongy. Thus we had ot only palpable hyperæmia, (which, as many pathologists believe, may ructures during life, and yet leave no positive trace behind,*) but also a of structure, characteristic of inflammation, the change having occurred in f nutrition of the nervous tissue.

at a few observers, on the ground even of a reference to the results of ana- l, have objected to the doctrine of hyperæmia, of any part of the nervous atic Tetanus. Thus Dr. Gerhard of Philadelphia, states that he has ex- and spinal marrow in ten or twelve cases, and that he could not detect any ed to have the slightest influence upon the production of the symptoms.† die, and others, have made a similar observation. Two replies may be ing this allegation, both of which appear to me of great weight. In the pt the language of Dr. Cowan, (spoken generally, and not in reference to bject), the narrow limits of unaided sense are again marvellously enlarged discovery, our past acquisitions regarded as elementary and incomplete, and is again to undergo renewed and unexpected revisions.‡ In short, the ns of the nervous structure commenced by Ehrenberg, with the aid of the ises to throw a stronger light on its pathology, even than it does on its e next place, post-mortem examinations of tetanic patients have been mostly , the brain and spinal marrow having been usually alone examined, and the nervous system having been comparatively seldom explored. Before peræmia of some part of the nervous system in Traumatic Tetanus, can be proved, we must have the whole of the nervous system examined, and opically. This negative mode of reasoning, is strengthened by much positive the scalpel, that different parts of the nervous system are found after death, ondition. 'In the greater number of observed cases,' says Dr. Dunglison, e medulla or its membranes, has been found on dissection.' Even Mr. at 'serous effusion, with increased vascularity, is generally observed in the ing the medulla spinalis, and also a turgid state of the blood-vessels about nerves. Treatise on Tetanus, p. 47. Dr. Saunders also states, as the result inquiries in tetanus, that if any muscle, voluntary or involuntary, has been m, it is found on examination, that the nerves which supply that muscle turgid vessels at their visible origins, or where they appear to set off from oblongata, or spinal marrow; but that the nerve serving the muscles, bored under spasm or convulsion are free from turgid vessels. Ed. Med. vol. xvi, p. 474.

ons of Mr. Swan, that the ganglia of the grand sympathetic nerves, are the ous system, to which irritation arising in the intestinal canal, tends, and ceeds to the rest of the nervous system, constitutes another link in the confirmatory of the hyperæmic theory of Tetanus. Irritation set up in iously disturbs the capillary circulation in them, and hence, probably the

e of Medicine, vol. i, p. 74.

e of Medicine, vol. ii, p. 330.

Provincial Medical and Surg. Association, N. S., vol. i, p. 4.

spasms. In the case which illustrates Mr. Swan's remark,—one of acute idiopathic tetanus, —'the villous coat of the small intestines throughout, had the marks of having been in a state of great irritation, many very vascular patches were observed on it, and it was loaded with a green and yellow slime and mucus.' Along with these appearances in the small intestines, he records that 'in all the ganglia of the grand sympathetic nerve, there existed decided marks of irritation.' The vessels usually pale and colorless were injected with red blood, and the same was observed in some of the intermediate portions of the nerve. The left semilunar ganglion exhibited a few vessels, but the right was injected in a beautifully minute manner, quite as much so when seen through a magnifying glass, as the conjunctiva in a state of high inflammation. This fact harmonizes with an interesting exhibition of the highly congested state of the ganglia of the sympathetic in cholera patients, as shown to me by the late Dr. Mackintosh of Edinburgh, in his extensive museum of morbid anatomy. The phenomena in both cases, threw the strong light of analogy on the assumed hyperæmic condition of the nervous centres, or of the sympathetic system, or of the nerves immediately connected with the seat of injury in tetanus; the spasmodic contractions both in tetanus and cholera, apparently owning a similar cause." Lancet, 1846, vol. i, January 10th, p. 40.

Dr. William Aitken, in the section of the second volume of his work on the "*Science and Practice of Medicine*," which relates to the discoveries regarding the structure and functions of the spinal cord and nerves, records the following important observations on the pathology of Tetanus.

Four cases of tetanus which he accurately examined, all exhibited one character in common, which pointed out the spinal cord as the seat of lesion in the formidable malady. The lesion discovered by Dr. Aitken, was not manifest to the naked eye, but was determined to exist with certainty by an examination of the Specific Gravity of the cord substance. For this purpose, the cord was separated from its nerves, and divided into parts of a uniform size, and the Specific Gravity of each determined:

"Each of the four cases showed that the general specific gravity of the cord throughout, is increased in cases of tetanus, the average specific gravity of the healthy cord, being 1.036. They showed also, that a change is *suddenly* indicated about the region of the cord in immediate communication with the wounded part, and that in one case of idiopathic tetanus, the change was uniform throughout. In the first case I examined where the wound was on the occiput, the uppermost three inches of the cord were of the highest specific gravity, and the difference became *suddenly* and *not gradually*, manifest at the fourth inch. In the third case, a very marked difference was apparent when the cervical region was compared with the rest of the cord; and the difference was suddenly marked, where the roots of the cervical and first dorsal nerves left the cord to form the brachial plexus. The wound in this instance was on the fingers.

"Mr. Lockhart Clarke has since examined the cord in tetanus cases microscopically, and has found peculiar lesions of a most minute kind, scattered throughout its substance. Med. Clin. Reports, August, 1865.

"In the last case the difference was suddenly manifested in the lowermost part of the cord, corresponding to the region where the nerves were in communication with the lower limbs, which were the seat of the injury." Glasgow Medical Journal, No. iv, January, 1854. Science and Practice of Medicine, Am. Ed. from 4th London Ed., vol. ii, p. 479.

According to the more recent labors of Rokitansky and Démme (Schmidt's Jahrbucher, vol. cxii), tetanus has a constant anatomical lesion, consisting in a proliferation of the connective tissue of the whole medullary substance, of the medulla oblongata, of the inferior peduncles of the cerebellum, of the crura cerebri, and of the spinal cord, producing a viscous mass abounding in nuclei, and never progressing to the formation of fibres. It is frequently mentioned, that great congestion of the brain and spinal cord was observed, a condition on which the lesions of the connective tissue just described, are believed to depend. (Southern Medical and Surgical Journal, edited by Joseph Jones, M. D., July, 1866, p. 116).

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In a case of Traumatic Tetanus, occurring in a German Butcher, aged 45, which proved fatal on the 4th day, reported by Dr. Erskine Mason, acting House Surgeon of Bellevue Hospital, (Am. Med. Times, Sept. 1, 1860, pp. 150–1): there was considerable effusion over the membranes of the spinal cord, which were very much congested. The cord was also exceedingly softened. The dura mater of the brain was natural, superficial vessels very much injected and of arterial hue. Brain substance very much softened, as well as the medulla oblongata. There was no effusion in the ventricles, the other organs were not examined.

Mr. Lockhart Clarke, in his communication *On the Pathology of Tetanus*, in vol. xlviii, 1865, of the Medico Chir. Trans.: observes that in six cases the spinal cord exhibited lesions of structure of different kinds and frequently of surprising extent. According to this observer, the pathological alteration seems to consist of disintegration and softening of a portion of the gray substance of the cord, which appeared in certain parts to be in a state of solution. The fluid thus formed, however, is at first, more or less granular, holding in suspension the fragments and particles of the disintegrated tissue, but in many places it is perfectly pellucid. Mr. Clarke asks, whether the structural lesions, and disintegration of tissue are the effects of the functional excitement of the cord, manifested in the tetanic spasms? or are they the cause of the spasms? He negatives the former question, and as to the latter, he states that they are not the direct or sole cause, since in those cases of paralysis, in which similar lesions exist, they do not give rise to tetanic spasms or convulsions. He believes that the lesions depend on the conjoint operation of injury of the peripheral nerves; with hyperæmia and a morbid state of the blood-vessels of the cord, and the resulting exudations and degenerations. Mr. Clarke finds the lesions of structure, consisting in exudations and disintegrations of tissue, precisely similar in character, to those discovered in the cord, in many ordinary cases of paralysis; and on comparing together the lesions and symptoms of both kinds of diseases, he arrives at the following conclusions: 1st. That the lesions are either not present, or are present only in a slight degree, in those cases of tetanus which recover. 2d. That they are not the effects of the great functional activity of the cord manifested in the violent spasms, but are the effects of a morbid state of the blood-vessels. 3d. That they are not alone the causes of the tetanic spasms. 4th. That the tetanic spasms depend upon two separate causes: first, on a morbidly excitable condition of the gray substance of the cord, induced by the hyperæmia and morbid state of its blood-vessels, with the exudations and disintegrations resulting therefrom. This state of the cord may be either an extension of a similar state along the injured nerves from the periphery, or may result from reflex action on its blood-vessels, excited by those nerves, secondly, that the spasms depend on the persistent irritation of the peripheral nerves, by which the exalted excitability of the cord is aroused; and thus the cause which at first induced in the cord its morbid susceptibility to reflex action, is the same which is subsequently the source of that irritation, by which the reflex action is excited. (*A System of Surgery*, edited by T. Holmes, 2d Ed., vol. i. Studies on Functional Nervous Diseases by C. Handfield Jones, 2d Ed., p. 237).

Dr. Dickinson, in vol. li, of the Medico-Chirurgical Transactions, p. 265, et seq., has given a very accurate description of the spinal cord, in a case of Traumatic Tetanus, in a man, aged 25 years, who died in eighteen and a half hours. The following are the alterations described by this writer. The cord presented three remarkable enlargements, one in the cervical, and two in the lumbar region. The morbid changes were 1st, a general intense injection of the cord, with dilatation of the blood-vessels in the gray matter, more than in the white, and in the left posterior horn, more than in the rest of the gray matter. The blood-vessels of certain portions of the cord, were replete to distension with the natural contents, and in some situations, blood corpuscles had escaped from their proper channels, and diffused themselves among the nervous elements.

2d. A structureless, transparent material had been poured out in the immediate vicinity of the vessels, not only into such vacant spaces as exist in the fissures of the cord, but forcibly intruded into many parts of the solid structure, tearing up the tissue and displacing the neighboring parts. Besides these changes, which affected both the white and gray matter, the white columns presented circumscribed alterations, which, in conjunction with the effusion described, caused the swellings which were so conspicuous on the surface of the cord.

Both Mr. Clarke and Mr. Dickinson recognize fully the existence and importance of peripheral irritation, and do not attribute more to the organic lesions they have discovered, in the way of causation, than that they promote and intensify the morbid action. Mr. C. Handfield Jones very justly remarks, that it is possible that the existence of such lesions in the cord, after recovery, may account for the persistence of certain symptoms in a modified form, as a degree of painful rigidity of the muscles, very liable to be aggravated by slight causes, or the peculiar alteration of the features noticed in a case recorded by Dr. Currie, when it is said that the patient's eyes appear hollow, his face sharp and pale, his cheeks and lips being skinny, and his masseter muscles hard and shrivelled;—such alterations are very suggestive of persistent spasm of the vaso-motor and musculo-motor nerves, which must depend on some abiding lesion.

Dr. Clifford Allbutt has recently reported several cases of Traumatic Tetanus to the Pathological Society of London. Comparing the appearances of the cord in the several cases, it was seen that they were similar, only differing in degree as regards softening; in two out of the four cases, meningeal hæmorrhages were observed, the vessels of the cord were greatly distended, thickened, varicose and plugged; and in one case there was universal thrombosis, with spaces around the vessels filled with matter, resulting from the granular disintegration of the clots. In two of the cases, there was considerable blood-staining of the cord, by oozing from, if not actual rupture of the vessels, and in two cases hæmorrhage into the cord in different places. Both in the pia-mater and in the central gray matter similar vascular changes were observed. The central canal of the cord was stuffed with epithelial matter in over-abundance. There was nuclear proliferation in the connective tissue, probably in excess of health. The cells in the anterior horns were singularly wasted in a very symmetrical manner;—no doubt due in part to exudation about the vessels, but also to changes in the cells themselves. The cells were the subject of yellow disintegration, beginning in the centre of the cells, and invading them from centre to periphery. Many were seen to have run together, forming an irregular, and more or less fatty mass, these masses giving rise to the appearance of small yellow masses in the anterior horns. At any rate, the latter were destroyed more or less by exudation into them, and peculiar degenerate changes in the cells. Dr. Allbutt considered the hæmorrhage and thrombosis as ante-mortem, and not post-mortem conditions.—London Lancet, February 25th, 1871, p. 270.

The improved physical and chemical methods of modern pathological research, will, without doubt, in the progress of careful investigation, render still more accurate our knowledge of the lesions of Traumatic Tetanus; but the facts recorded in this chapter are amply sufficient to show that this disease is characterized by distinct and recognizable lesions of the spinal axis.

COMPARISON OF THE LESIONS OF THE CEREBRO-SPINAL SYSTEM IN TRAUMATIC TETANUS, WITH THOSE OBSERVED IN VARIOUS DISEASES OF THE NERVOUS SYSTEM, AS EPILEPSY, SYPHILITIC NEUROSES, INSANITY AND PARALYSIS.

It is important that we should in the next place compare the lesions discovered in the cerebro-spinal system in Traumatic Tetanus, with those observed in other diseases of the nervous system. Whilst we have observed a large number of diseases dependent upon functional and structural alterations of the nervous system, we shall, in illustrating this comparison, confine ourselves to those cases which we have had the time and opportunity to study during life and to examine after death. In this country it is rarely within the power of the physician to make careful post-mortems in fatal cases occurring in private practice, and many of the most important cases of nervous diseases, which we have treated and studied with care and interest for long periods of time, as well as such sudden and fatal cases as occur in Traumatic Tetanus and cerebro-spinal meningitis, have unavoidably been lost, without that final minute post-mortem examination, which would have given precision and value to the careful observations during life.

I shall, therefore, in selecting cases for record and comparison, confine myself to those which I was enabled to complete the investigation after death, in virtue of the pres- se of the patients within the walls of an hospital.

se 52: *Loss of Mental Power (partial insanity), ending in Coma, Delirium and Death, and attended with Structural Alterations of Brain.*

harles U., aged 28 years; a native of Dublin, Ireland; has been in the United States ny for several years, served during the recent war, and worked his way up from the ranks he position of 1st Lieutenant; was mustered out of service at Greenville, in March, 1868, hich time he moved to New Orleans, and entered the family of Mrs. A. Patient assisted A. in various ways, doing work about the house as directed. After a time, about six ths before his final illness, it was noticed that the patient exhibited less intelligence than nerly. The intellectual powers appeared to fail gradually, and the patient became "unre- le," and when sent on an errand, would go to some other place than the one specified. ee weeks before his entrance into the Charity Hospital became delirous and insensible, h short lucid intervals, when he appeared to recognize Mrs. A. and her family. Bowels stipated, and during three weeks, is said to have had only one action from the bowels. The nding physician applied a blister over the head, and administered purgatives, but with- any apparent benefit.

ntered Charity Hospital March 8th, 1869, ward 29, bed 430. Medium height; blue eyes; t hair, red beard; reduced in flesh; lies in a state of delirium and apparent insensibility, not be aroused; twitching of tendons and picking of bed-clothes. Bowels obstinately stipated; passes his urine in the bed, which has a powerful ammoniacal odor.

urgatives were freely administered, and a blister was applied to his head; these measures, ever, produced no perceptible benefit, and the patient died on the fourth day after his ission.

utopsy eight hours after Death.—The *Brain and Spinal Marrow* were carefully removed. The -mater and arachnoid were thickened, with fibrinous deposits thrown out, especially along track of the blood-vessels.

he two hemispheres of the brain were firmly adherent, and could only be separated by section with the scalpel.

lood-vessels of pia-mater greatly congested with blood. Gray matter of brain congested; ite matter somewhat softened. Fibrinous effusion around base of brain.

ia-mater and arachnoid of spinal cord, greatly congested with blood and the blood-vessels the spinal cord were not only distended to their full capacity with blood, but they also sented a tortuous and varicose appearance. Gray matter of cord somewhat congested; ite matter softened. The spinal cord was removed and examined throughout its entire gth.

The blood-vessels of the brain presented not only an enlarged appearance, but thickened lls.

Microscopical examination showed that the fibrinous effusion was being organized, and that changes in the membranes of the brain were of slow development, and dated back in ir origin, weeks and even months.

The two hemispheres of the cerebrum, were so completely adherent, that the longitudinal sure could be displayed only by the use of the scalpel and considerable force.

The sympathetic nervous system was dissected out, and examined microscopically, no evi- nce of disease was discovered in it.

The *lungs* and *heart* were normal. The abdominal viscera presented nothing unusual, with exception of a light bronze color of the liver, and some enlargement of the spleen.

These changes of the spleen and liver however, were of long standing and had no connec- n whatever with the fatal attack. The liver and spleen, when cut and exposed to the ion of the atmosphere, assumed a bright arterial hue.

idneys congested, but otherwise healthy.

In this case we have an instance of the connection of deranged mental action with uctural alteration of the brain and its membranes.

se 53: *Temporary Insanity, occurring occasionally during a period of years, followed finally by Loss of Mental Power, Paralysis and Death. Structural Alterations discovered in the Brain and Spinal Cord.*

ohn L. B., native of Mississippi, aged 50 years, admitted to ward No. 28, bed 416, Charity spital, October 20th, 1868; was in comfortable circumstances previous to the recent civil r, and has a wife and family.

Twelve years ago attempted to take the life of his partner, without any known cause, and since that time has had occasional fits of temporary insanity, although he has continued in business.

Three years after the attack on his partner with fire-arms, he killed his horse, cutting its throat in the road, whilst harnessed in his buggy, without (as in the first instance), any known reason for the outburst of passion. The patient is said to have continued in a wild delirious state for several days after these violent manifestations. During the war lost his property, and at its close roamed about the country in a demented but harmless state.

At the time of his entrance into the hospital, walked with great difficulty,—spoke slowly and with effort, mind obtuse, and patient gives no rational history of his past life, each time giving a new story. In attempting to walk about the wards, fell several times; motions feeble and unsteady; apparant want of co-ordination of the muscular motion; cannot turn without help in bed, requires assistance in dressing. Sensation apparently impaired. General appearance that of a large, stout man, with full limbs, but in a low cachetic state, with pale, sallow complexion. Passes his urine and fæces in bed at night.

The powers continued gradually to fail, and with this progressive loss of muscular and nervous power, the circulation in the extremities appeared to grow more sluggish. January 1st, 1869, the patient has several large bed-sores upon the hips, caused by pressure, and the action of the involuntary discharges of urine. The bed-sores were dressed with a cerate composed of one drachm of crystallized Carbolic acid mixed with one ounce of Simple cerate. The internal treatment consisted of one-twentieth of a grain of Strychnine, and fifteen drops of the tincture of the Sesqui-Chloride of iron, three times a day, together with the most nutritious diet afforded by the hospital; under this treatment, with attention to the state of the bowels, and to the personal cleanliness of the patient, with occasional blisters to the back of the neck, the general health improved in a marked manner; there was a temporary increase of muscular power, the patient became more cheerful and rested better at night; and at the same time, effects of the iron were manifested in an improvement in the complexion. The bed-sores also healed rapidly and fully. This improvement, however, was only temporary, and in the early part of February, the difficulty of walking became so great, and the tendency to fall, even when sitting in the chair, so constant, that the patient was compelled to lie the most of the time in bed. Remains as usual in a vacant, listless state.

The powers have progressively failed up to the present time, February, 19th, when the patient lies in a state of mental vacuity, with mouth open, and eyes staring, unable to answer the simplest question intelligently; with almost complete loss of muscular power in the lower extremities, and with large bed-sores forming upon the exposed parts of the trunk, notwithstanding every effort to prevent their appearance, by friction and stimulating applications.

The students had daily opportunities of witnessing the gradual and progressive failure of the intellect, and muscular and nervous forces in this patient; the progressive loss of power, was also clearly shown in the fact that in December, the patient was able, with supports on either side, to walk down from the third story of the hospital to the floor of the amphitheatre on the first floor. In January it was necessary to bring the patient down in a chair; and at the present time he lies prostrate unable to sit up.

It is worthy of note that up to the present time, there has been no fever, no increase of respiration or circulation, or of animal temperature, and the nutritive functions have been performed with regularity.

From the history of this case, we are justified in the conclusion that the disease of the brain has been of long standing; that the *insanity* was dependent upon some *structural alteration of the brain;* and that the *alteration*, degeneration or softening of the brain has gradually extended to, and affected the spinal system.

This case presents a progressive failure of the intellectual, nervous and muscular forces, without any sudden paralysis or contraction of the muscles, and the only sudden and violent nervous agitation with which the patient was afflicted since his entrance into the hospital was a slight convulsion about noon on the 12th of February, after making unusual efforts at sitting up and attempting to walk. So far as could be learned, this was the only attack of this kind that he had ever had, and we are led to exclude epilepsy as the cause of the progressive failure of the intellectual and nervous powers.

The patient continued progressively to fail; lay in an unconscious condition, occasionally groaning and crying aloud, especially at night, when he disturbed the entire ward. One fourth of a grain of Morphine, was tried at bed-time, without any special benefit. The patient does not reply when addressed, and appears to be wholly unconscious of any thing passing around him, and is oblivious of his distressing condition. Urine and fæces passed in bed; bed-sore forming upon back over sacrum; circulation sluggish; surface of the skin in dependent portions of the body, of a purplish red, mottled appearance. Patient unable to turn in bed, or to move his lower extremities. When the feet and legs are pinched, the patient contorts the face, and evidently suffers pain.

The patient continued to sink; gradually lost the power of swallowing, and could take no

breath became very offensive, and the teeth loaded with sordes; four days
the right thigh was contracted and drawn up towards the trunk. Patient
affer pain when the attempt was made to straighten the limb.
3d, at 8 o'clock, P. M.
itopsy was made the next morning, at 8 A. M., with the following result:
ll and not wasted; *heart* normal; *lungs* pale, but perfectly healthy, with no
ıentary canal and all the abdominal organs, liver, spleen, and kidneys normal

l-formed and large cranium, with symmetrical arch. Nothing peculiar, however,
h reference to the cranium.
firmly adherent to the bony structure; pia-mater, greatly congested and thick-
chnoid was in like manner thickened, and presented much more of an opalescent
an usual.
well formed, and unusually firm. The blood-vessels of the nutritive membrane
were everywhere larger, more numerous and more congested than in healthy
condition was in no manner connected with mere stasis of blood, because it was
most elevated portions of the brain, as in the most dependent. When cut, sec-
rain revealed a state of remarkable congestion. The congestion was greatest
tter of the convolutions and of the optic thalami, giving to those collections of
tter a pink high-colored appearance.
essels of the brain *in all parts*, were larger and more numerous and more con-
healthy brains. The blood-vessels were not only more congested, but they
lly enlarged.
ze of the small blood-vessels and evên of the capillaries, as well as the state of
parted to the gray matter a deep pinkish tint.
roscope, the ganglionic cells of the gray matter, and ganglia of the brain appeared to
number, whilst the capillaries were increased in size, with thickened walls. Exudation
observed amongst the brain structures, and especially along the tracks of the blood-

er of the spinal cord was congested in a similar manner. The spinal cord was
ound by a net-work of large anastomosing (varicose) blood-vessels, engorged
The blood-vessels appeared to be fourfold more numerous than in health. Upon
ood-vessels of the spinal cord, in all parts, were found to be similar to those of
and cerebellum. They were greatly enlarged and congested with blood.
were largest, most numerous and most congested in the gray matter (ganglionic
ıs), of the interior of the cord. So marked was the enlargement of the blood-
cord, and so great was the congestion of blood in them, that the gray matter
erywhere presented a bright-red color, wholly different from the gray color of
ord was firm in texture. Under the microscope, the ganglionic cells appeared
merous in the gray matter of the spinal cord, than the gray matter of the brain;
ries were enlarged and their walls greatly thickened. *Exudation corpuscles, were*
neighborhood and around the capillaries; and both in the spinal cord, and in the brain,
of the coloring matter of the blood were discovered in the textures.
ion whether the insanity was caused by this congestion and enlarged capillary
The temporary nature of the fits, as well as their violence, would indicate that the primary
the circulatory apparatus of the brain and spinal cord.

e, we have as in the preceding one, an instance of the *connection of*
ıtal action with structural alterations of the brain.
eat importance to the science of medicine, that every case of insanity,
ly be subjected to the most rigid investigation during life, but also that
ful examination of the nerve structures, should be made after death.
is liable to disease, as well as any other organ in the body, and as it is the
intellectual faculties, it makes a vast and important difference in our
iews and therapeutical principles, whether we regard insanity as connected
endent upon structural alterations, or as a disorder of the intellectual
moral power.
ious causes may be active in the production of that terrible state, in which
led to the level of the brute, by loss of those powers which enable him to
ntrol the forces of matter, and even immaterial agents; it is certainly of
nce to medical science to determine with utmost accuracy the structural
brain and spinal cord, in all the various forms of insanity.
d important field of research is opened to the medical superintendents,

directors and attending physicians of the various Insane Asylums in this country. Each case of insanity should be subjected to rigid scrutiny; accurate measurements should be made of the cranium, and all peculiarities of conformation and of physiognomy should be noted and compared with the peculiar phases of the insanity; and this careful examination should be completed by a thorough examination of the brain after death. If a small portion of the funds of each State Asylum were devoted to the careful investigation and delineation of the peculiar conformation of the cranium and countenance (by photography), and to the publication of the annual results of the pathological labors conducted by competent men, important results would be achieved for the science of medicine.

The researches of Pathologists are gradually undermining the theory or belief, so long held, that Insanity is an affection of the mental and moral nature, or immaterial principle, independent altogether of structural alteration of the material instruments by which the mind manifests itself. The question as to the relations of pathological alterations of the brain, to aberrated moral and intellectual manifestations, cannot be determined by any process of reasoning, but must be settled by careful pathological researches.

The belief that in Insanity, the encephalic nervous textures are primarily implicated, gains ground, and is now ably supported by such men as Van Der Kolk, Winslow, Bushnan, Bucknill, Tuke and Laycock. Van Der Kolk says, that more than thirty years' experience has led him to a totally opposite opinion to those who deny that in the insane, the phenomena found in the dead body, throw any light on the nature and course of the disease:

> "And I do not remember to have performed during the last twenty-five years, the dissection of an insane person, which did not afford a satisfactory explanation of the phenomena observed during life." Minute Structure and Functions of the Spinal Cord and Medulla Oblongata, etc. New Syd. Soc. Pub., vol. iv, p. 231.

The researches of Drs. Saukey, Bucknill, Skae and Boyd, have established the existence of marked variations in the specific gravity of the brain and its component parts in insanity. Bayle, Delaze, Calmeil, Pachappe, Linas and others, have shown that the general paralysis of the Insane, is the effect of an inflammation of the encephalon, or of its membranes.

Bayle opened one hundred corpses of paralytic insane, and Calmeil forty-seven; these observers found the meninges of the convexity of the cerebral lobes opaque, injected, hardened. infiltrated with serosity, and offering frequently granulations or false membranes.

M. Linas opened one hundred and fourteen bodies of paralytic insane: in twelve cases the pia-mater was excessively injected; the cerebral substance was quite full of blood, the gray matter being from an intense red, to a dark violet color. In twenty-eight cases, besides the preceding alterations, there were adhesions between the convolutions and the meninges. In seventy-four cases the meninges were infiltrated, opaque, and as tough as a fibrous membrane; the cortical substance of the brain, sometimes violet, sometimes yellowish, according to the degree of the paralysis, always softened, less thick than in normal brains; the white substance injected, and sometimes infiltrated; the convolutions meagre, and the whole mass of the brain more or less atrophied. In thirteen cases besides the preceding alterations, there was one or many small circumscribed places where the encephalitis had been more violent than elsewhere. In eight cases, there were also effusions of blood.

From these facts, it appears that paralysis of the insane depends upon a chronic inflammation of the brain and its meninges. Whether the disease begins in the membrane as Bayle has said, or in the brain itself, as M. Calmeil maintains, is a question of comparatively little importance. The great point is, that the brain is always inflamed. M. Calmeil has ascertained with the microscope, that in doubtful cases, where the brain did not seem to be much altered to the naked eye, there were nevertheless, all the icroscopic appearances of inflammation. M. Linas has recorded cases to prove that acute cephalitis may cause the paralysis of the insane. As regards the first symp- ms of this affection, M. Linas declares, that sometimes, intellectual disorders first ppear, and in other cases, muscular paralysis and insanity appear at the same time.

Case 54: Insanity caused by Syphilis: Structural Alteration of Brain.

The case was that of a white female, who had had syphilis, and the mental derangement ame on, after the supervention of constitutional symptoms, and appeared to be directly eferable to the structural changes induced in the brain by the syphilitic poison.

It was observed during the life of the patient, that she was insensible to bad odors. Thus, s she was suffering from diarrhœa, the excrementitious matters were frequently daubed upon er nose and face, by her own hands, and the patient appeared even in the lucid moments, to e wholly oblivious to their presence and offensive odor.

After death, it was found that the structures of the brain, were extensively softened and ltered in the neighborhood of the origin of the olfactory nerves.

The alterations of the brain and the symptoms of insanity, in this case, were referred o the action of the syphilitic poison.

It has been established by the researches of various observers, that the brain may e affected *indirectly* by syphilis, as in caries, necrosis, exostosis of the cranial bones, ummy tumor of the skull, or deposits in the dura-mater, which membrane has been ompared to an internal periosteum.

These lesions may excite inflammation of the dura-mater, which may extend to the rachnoid, pia-mater and surface of the hemispheres.

It has in like manner been shown that the brain may be directly affected by syphilis; he nervous substance being the seat of syphilitic, gummy deposit, followed by soften- g, and cases have been recorded, in which white and red softening of the cerebral ubstance have been caused by syphilis.

In the neuralgic affections, paralysis, epilepsy, and dementia, following the appear- nce of the constitutional effects of syphilis, good results, and even effectual cures may e obtained by the judicious use of the Bi-chloride and Bin-iodide of Mercury, and the odide of Potassium.

The syphilitic poison induces profound alterations in the constitution of the blood, nd marked derangement in the nutrition of the tissues and organs, and especially of he nervous structures, and the syphilitic origin of many nervous diseases is at present dmitted by those practitioners who hold that syphilis ought always to be considered as possible cause in cases of obscure nervous disease, where its existence is not manifestly mpossible. I fully endorse the opinion of Dr. Thomas Buzzard, that if the physician aits to act in an anti-syphilitic sense, until he obtains a clear and unmistakable history f past syphilis, he will lose many lives, and leave uncured a great deal of perfectly urable nervous disease.

During the past twenty years I have treated a number of cases of insanity, epilepsy, aralysis, sciatica, and various forms of neuralgia in hospital and private practice, which ad been induced by the action of the syphilitic poison, and which were relieved in ost instances by the free and continuous employment of mercurials, iodides of mer- ury, iron and potassium, and the various preparations of iron and arsenic; it would be oreign, however, to the present inquiry to detail these cases, or to enter upon any dis- ussion of the relations of syphilis to various diseases, and especially to those of the ervous system. Like malaria, the syphilitic poison induces such changes in the blood nd tissues as modify the character and progress of all supervening diseases; and the pace afforded by an entire volume would be scarcely sufficient to discuss these rela- ons. I will therefore dismiss this subject, with the observation, that I have derived he greatest benefit from the Bi-chloride or Bin-iodide of Mercury, in combination with the Iodide of Potassium, given in the proportion of one-sixteenth of a grain of either the Bi-chloride or Bin-iodide of Mercury, to from three grains to two scruples of the Iodide of Potassium, three times a day. The following is a convenient formula; R.

Hydrargyri Bin-iodidi, four grains; Potassæ Iodidi, one ounce; Aquæ distillatæ eight fluidounces; mix; sig., teaspoonful in wineglassfull of water three times a day. When it is desirable to use the iodide of iron in combination with the iodide of potassium, the following formula has been found convenient: R. Potassæ iodidi, one ounce; Tinct. iodinii, two fluiddrachms; Syrupi Ferri Iodidi, one fluidounce; syrupi Zingiberis, seven fluidounces; mix; sig., teaspoonful in wineglassfull of water three times a day. In the severest cases of nervous derangement I have used the Iodide of potassium freely in doses varying from one scruple to two drachms, three times a day.

In anæmic cases, and especially in those patients who had been subjected to the combined action of malaria and the syphilitic poison, the following remedies have been used alternately with the iodides of mercury and potassium: R. Strychniæ sulph., two grains; Quiniæ sulph., two drachms; Ferri et Quiniæ citratis, four drachms; Acidi Citrici, three drachms; Aquæ distillatæ, eight fluid ounces; make a solution; sig., teaspoonfull in wineglassfull of water, three times a day. Also, as a substitute for the preceding: R. Strychniæ sulph., three grains; Acidi Arseniosi, two grains; Quiniæ sulph., three drachms; Ferri redac., two drachms; Extract Rhei, two drachms; mix; divide into one hundred pills; sig., one pill, three times a day. Each of the preceding prescriptions constitute what may be called a course, extending about three weeks. In many cases it is necessary to repeat these remedies at regular intervals during periods varying from two months to eighteen months, and even longer. Failure in the treatment of such cases frequently arises from the irregular and timid use of mercurials and the Iodide of Potassium.

Case 55: Dementia, Paralysis and Death; Clots in Corpora Striata and Optic Thalami.

In this case the patient, a negro woman, was brought into the hospital in a dull, listless, speechless state, with loss of muscular power, and want of coördination of the muscular movements, and it was said by her companions that she had been the victim of sorcery or witchcraft. The disease was said to have been suddenly induced in a state of health, by an aged negress, who practiced witchcraft.

After death, it was found that blood-vessels had been ruptured, and blood extravasated into the gray matter and nervous structures of the *optic thalami and corpora striata*. The patient was a large, stout old woman, apparently near seventy years of age, and the ruptured blood-vessels were found to be degenerated, having undergone fatty degeneration. It is possible that the rupture of the blood-vessels may have been the result of some unusual mental or physical effort.

As the practice of sorcery and witchcraft amongst the negroes in certain sections of the South, is thought to have been revived and extended since the war, we reproduce one of the fullest and most accurate accounts of the superstitious practices of the negroes.

The following very curious account of the extraordinary superstition of the African race, was transmitted by the agent of Jamaica to the Lords of the Committee of Privy Council, and by them subjoined to their report on the slave trade, and it is said to have been the result of the diligent researches and accurate pen of Mr. Long.

The term Obeah, Obiah, or Obia, (for it is variously written), we conceive to be the adjective, and Obe, or Obi, the noun substantive; and that by the word Obia—men or women—are meant, those who practice Obi. The origin of the term we should consider of no importance in our answer to the questions proposed, if, in search of it, we were not led to disquisitions that are highly gratifying to curiosity. From the learned Mr. Bryant's* commentary upon the word Oph, we obtain a very probable etymology of the term. A serpent, in the Egyptian language, was called Ob or Aub—Obion is still the Egyptian name for a serpent. Moses, in the name of God, forbids the Israelites ever to enquire of the demon, Ob, which is translated in our Bible, charmer, or wizard, divinator, aut sortilegus. The woman at Endor is called Oub or Ob, translated Pythonissa; and Oubaios (he cites from *Horus Appollo*), was the name of the Basilisk or Royal Serpent, emblem of the sun, and an ancient oracular deity of Africa. This derivation, which applies to one particular sect, the remnant probably of a very celebrated religious order in remote ages, is now become in Jamaica the general term to denote those Africans, who, in that Island, practice witchcraft or sorcery, comprehending also the class of what are called Myal-men, or those who, by means of a narcotic potion, made with the juice of an herb (said to be the branched *calalue* or species of *solanum*) which occasions a trance or profound sleep of a certain duration, endeavor to convince the deluded spectators of their power to re-animate dead bodies.

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* Mythology, vol. I, pp. 48, 475 and 478.

As far as we are able to decide from our own experience and information, when we lived in the island, and from the current testimony of all the negroes we have ever conversed with on the subject, the professors of Obi are, and always were, natives of Africa, and none other; and they have brought the science with them from thence to Jamaica, where it is so universally practiced, that we believe that there are few of the large estates possessing native Africans, which have not one or more of them. The oldest and most crafty are those who usually attract the greatest devotion and confidence; those whose hoary heads, and somewhat peculiarly harsh and forbidding aspect, together with some skill in plants of the medicinal and poisonous species have qualified them for successful imposition upon the weak and credulous. The negroes in general, whether Africans or Creoles, revere, consult and fear them; to these oracles they resort, and with the most implicit faith, upon all occasions, whether for the cure of disorders, the obtaining revenge for injuries or insults, the conciliating of favors, the discovery and punishment of the thief or the adulterer, and the prediction of future events. The trade which these impostors carry on is extremely lucrative; they manufacture and sell their Obies adopted to different cases, and at different prices. A veil of mystery is studiously thrown over their incantations, to which the midnight hours are alloted, and every precaution is taken to conceal them from the knowledge and discovery of the white people. The deluded negroes, who thoroughly believe in their supernatural power, become the willing accomplices in this concealment, and the stoutest among them tremble at the very sight of the ragged bundle, the bottle of the egg-shells, which are stuck in the thatch, or hung over the door of a hut, or upon the branch of a plantain tree, to deter marauders. In cases of poison, the natural effects of it are by the ignorant negroes, ascribed entirely to the potent workings of *Obi*. The wiser negroes hesitate to reveal their suspicions, through a dread of incurring the terrible vengeance which is fulminated by the *Obeah-men* against any who should betray them; it is very difficult therefore, for the white proprietor, to distinguish the *Obeah professor* from any other negro upon his plantation; and so infatuated are the blacks in general, that but few instances occur of their having assumed courage enough to impeach these miscreants. With minds so firmly prepossessed, they no sooner find *Obi set for them* near the door of their houses, or in the path which leads to it, than they give themselves up for lost. When a negro is robbed of a fowl or a hog, he applies directly to the *Obeah* man or woman, it is then made known among his fellow blacks, that *Obi is set* for the thief; and as soon as the latter hears the dreadful news, his terrified imagination begins to work, no resource is left but in the superior skill of some more eminent *Obeah-men* of the neighborhood, who may counteract the magical operations of the other; but if no one can be found of higher rank and ability, or after gaining such an ally, he should still fancy himself affected, he presently falls into a decline, under the incessant horror of impending calamities. The slightest painful sensation in the head, the bowels, or any other part, any casual loss or hurt, confirms his apprehensions, and he believes himself the devoted victim of an invisible and irresistible agency. Sleep, appetite and cheerfulness forsake him, his strength decays, his disturbed imagination is haunted without respite, his features wear the settled gloom of despondency; dirt, or any other unwholesome substance become his only food, he contracts a morbid habit of body, and gradually sinks into the grave. A negro, who is taken ill, inquires of the *Obeah-man* the cause of his sickness, whether it will prove mortal or not, and within what time he shall die or recover? The oracle generally ascribes the distemper to the malice of some particular person; but if no hopes are given of recovery, immediate despair takes place, which no medicine can remove, and death is the certain consequence. Those anomalous symptoms, which originate from causes deeply rooted in the mind, such as the terrors of *Obi*, or from poisons, whose operation is slow and intricate, will baffle the skill of the ablest physician.

"Considering the multitude of occasions which may provoke the negroes to exercise the powers of *Obi* against each other, and the astonishing influence of this superstition upon their minds, we cannot but attribute a very considerable portion of the annual mortality among the negroes of Jamaica to this fascinating mischief."

"The Obi is usually composed of a farrago of material, most of which are enumerated in the Jamaica law,[*] viz: blood, feathers, parrots' beaks, dogs' teeth, alligators' teeth, broken bottles, grave dirt, rum and egg-shells."

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[*] Passed 1760.

Pere Labat,[*] in his history of Martinico, has mentioned some instances of this practice which are very remarkable.

"It may seem very extraordinary, that a practice alleged to be so frequent in Jamaica, should not have received an earlier check from the legislature. The truth is, that the skill of some negroes, in the art of poisoning, has been noticed here since the chemists became much acquainted with them. Sloan and Barham, who practiced physic in Jamaica in the last century, have mentioned particular instances of it. The secret and insidious manner in which this crime is generally perpetrated, makes the legal proof of it extremely difficult. Suspicions therefore have been frequent, but detections rare; these muderers have sometimes been brought to justice, but it is reasonable to believe that a far greater number have escaped with impunity. In regard to the other and more common tricks of Obi, such as hanging up feathers, bottles, egg-shells, etc., etc., in order to intimidate negroes of a thievish disposition from plundering huts, hog-styes or provision grounds, these were laughed at by the white inhabitants as harmless stratagems, contrived by the more sagacious for deterring the more simple and superstitious blacks, and serving for much the same purpose, as the scare-cows which are in general used among our English farmers and gardeners. But in the year 1760, when a very formidable insurrection of the Koromantyn or Gold Coast negroes broke out in the parish of St. Mary, and spread through almost every other district of the Island, an old Koromantyn negro, the chief instigator and oracle of the insurgents in that parish, who had administered the fetish or solemn oath to the conspirators, and furnished them with a magical preparation which was to render them invulnerable, was fortunately apprehended, convicted and hung up, with all his feathers and trumperies about him; and his execution struck the insurgents with a general panic, from which they never afterwards recovered. The examinations which were taken at that period, first opened the eyes of the public to the very dangerous tendency of the *Obeah* practices, and gave birth to the law which was then enacted for their suppression and punishment. But neither the tenor of this law, the strict investigation which has ever since been made after the professors of Obi, nor the many examples of those who from time to time have been hanged or transported, have hitherto produced the desired effect. We conclude, therefore, that either this sect, like others in the world, has flourished under persecution; or that fresh supplies are annually introduced from the African Seminaries."

Bryan Edwards, in his "History, Civil and Commercial, of the British Colonies in the West Indies," (1806, vol. ii, p. 303), quotes the following narrative from a planter in Jamaica, whom he characterizes as a gentleman of the strictest veracity:

"Upon returning to Jamaica, in the year 1775, he found that a great many of his negroes had died during his absence; and that of such as remained alive, at least one-half were debilitated, bloated and in a very deplorable condition. The mortality continued after his arrival, and two or three were frequently buried in one day; others were taken ill, and began to decline under the same symptoms. Every means were tried by medicines, and the most careful nursing, to preserve the lives of the feeblest; but in spite of all his endeavors, this depopulation went on for above a twelve months longer, with more or less intermission, and without his being able to ascertain the real cause, though the *Obeah practice* was strongly suspected, as well by himself as by the doctor, and other white persons upon the plantation, as it was known to be very common in that part of the island, and particularly among the negroes of the Pawpaw or Popo country. Still he was unable to verify his suspicions, because the patients constantly denied their having anything to do with persons of that order, or any knowledge of them. At length a negress, who had been ill for some time, came one day and informed him, that feeling that it was impossible for her to live much longer, she thought herself bound in duty, before she died, to impart a very great secret, and acquaint him with the true cause of her disorder, in hopes that the disclosure might prove the means of stopping that mischief, which had already swept away such a number of her fellow-slaves. She proceeded to say, that her step-mother, (a woman of the Popo country, above eighty years old, but still hale and active) had put Obi upon her, as she had also done upon those who had recently died; and that the old woman had practiced Obi for as many years as she could remember.

"The other negroes of the plantation no sooner heard of this impeachment, than they ran in a body to their master, and confirmed the truth of it, adding that she had carried on this business ever since her arrival from Africa, and was the terror of the whole neighborhood. Upon this he repaired directly, with six white servants, to the old woman's house, and forcing open the door, observed the whole inside of the roof, (which was of thatch), and every crevice of the walls, stuck with the implements of her trade, consisting of rags, feathers, bones of cats, and a thousand other articles. Examining further, a large earthen pot or jar,

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[*] Tome 11, p. 59, 447, 499, 506."

> ose covered, was found concealed under her bed. It contained a prodigious quantity of und balls of earth or clay of various dimensions, large and small, whitened on the outside d variously compounded, some with hair, or rags, or feathers of all sorts, and strongly und with twine; others blended with the upper section of the skulls of cats, or stuck und with cats' teeth and claws, or with human or dogs' teeth, and some glass beads of differ- t colors; there were also a great many egg-shells filled with a viscous or gummy substance, qualities of which he neglected to examine, and many little bags stuffed with a variety articles, the particulars of which cannot at this distance of time be recollected. The house s instantly pulled down, and with the whole of its contents committed to the flames, idst the general acclamations of all his other negroes.
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> In regard to the old woman, he declined bringing her to trial, under the law of the island, ich would have punished her with death; but, from a principle of humanity, delivered her o the hands of a party of Spaniards, who, (as she was thought not incapable of doing me trifling kind of work), were very glad to accept and carry her with them to Cuba. om the moment of her departure his negroes seemed all to be animated with new spirits, d the malady spread no farther among them. The total of his losses in the course of about teen years preceding the discovery, and imputable solely to the Obeah practice, he esti- ates at least one hundred negroes."

Some of these remarkable results may be referred to the force of the imagination, nd the power of fear over the animal economy; because it is well established, that the ervous system is not only the centre and channel of sensitive and motor impulses, onducting the motor influence of the will to the muscles, receiving and transmitting o the cerebral ganglia sensitive impressions from the exterior world, and balancing and ordinating the motions of the body, but is also intimately related to the acts of cir- ulation and respiration, and the nutrition and secretion of the organs.

Numerous examples might be given of the influence of fear over the bodily health: Thus, Schenckius relates the instance of a noble Spaniard, Don Diego Osorio, who, being n love with a young lady of the Court, had prevailed with her for a private confer- ence within the gardens of the King; but, by the barking of a little dog, their privacy was betrayed, the young gentleman seized by the King's guard and imprisoned. It was a capital offence to be found in that place, and Osorio was condemned to die. He was so terrified at hearing this sentence, that one and the same night saw the same person young and old, being turned gray, as in those stricken in years. Moved at the sight, the goaler related the accident to King Ferdinand as a prodigy, who thereupon pardoned him, saying he had been sufficiently punished for his fault.

A similar circumstance is related of a nobleman of the Roman Court, in the time of the Emperor Cæsar, who was also detected in an intrigue, cast into prison, and sen- tenced to be decapitated on the morrow.

Dr. Marshall Hall has recorded the case of a gentleman, who was suddenly affected with epileptic seizures, the effect of fear—the fear of the cholera. After each epileptic seizure, the hemiphlegic paralysis of the right side took place; but this yielded com- pletely, except that the patient could not direct his mind from the idea that the feeling of the affected side was somewhat different from that of the other. At length, a fourth attack proved fatal; and on a post-mortem examination, the arachnoid was found lightly opaque, the ventricles containing serum, whilst in the left corpus striatum there was the remnant of a small clot of blood in a cyst slightly discolored. The arachnoid was raised in one part by serum, resembling a vesicle, and a small vesicle was attached o the plexus choroides.

On the other hand, the effects of strong mental and moral emotions, as the heroic nthusiasm of the excited warrior and the devoted martyr, may completely deaden the ervous system to fear and pain, so that the dreadful wound and the burning flames re alike disregarded. In the dancing mania of the middle ages, described by Hecker, he patients, at the height of their excitement, seemed to have had their external senses literally sealed. "While dancing," says Hecker, "they neither saw nor heard, being insensible to external impressions through the senses."

Under the influence of fear and fright, paralyzed muscles and limbs that were useless, have suddenly been thrown into action, hæmorrhages have been instantaneously checked, and fits of the gout, ague, and other disorders of a periodic character have been cured.

Anger accelerates the progress of the blood, hurrying on the circulation with such fearful impetuosity, as to threaten the brain, and the organs contained in the chest; grief depresses the action of the heart, and causes serous accumulations in the large vessels and lungs, and gradually undermines the health of the body by weakening the energy of the nervous system, and causing the functions to be carried on in a slow and unequal manner; even excessive joy has been known to occasion as strange and fatal results as anger and grief.

Fienus mentions an instance of a malefactor who was carried out, as he conceived, to execution; and in order thereto his cap was pulled over his eyes, and a cold, wet cloth being struck hastily about his neck, he fell down dead, under the conceit of his decapitation. A similar case is recorded by Charron;—a man having his eyes covered to be put to death, as he imagined—being condemned—and uncovering them again to receive his pardon, was found really dead on the scaffold.

It is said, and the statement has been often repeated, that a person was directed to be bled to death; his eyes were blinded, and he was made to believe, by water trickling down his arms, that the sentence was being carried into effect. The mimicry is said to have produced death as effectually as would the real operation; the powers of life were destroyed by the power of imagination.

Sophocles, at an advanced age, and in full possession of his intellectual powers, composed a tragedy, which was crowned with such success, that he died through joy; Chilon, of Lacedemon, died from joy whilst embracing his son, who had borne away the prize at the Olympic Games; Juventius Thalma, to whom a triumph was decreed for subjugating Corsica, fell down dead at the foot of the altar, at which he was offering up his thanksgiving; and Fouquet, upon receiving the intelligence of Louis XIV. having restored him to liberty, fell down dead.

These and many other cases of sudden death, from powerful emotions and unexpected joys and sorrows, are doubtless to be attributed to the effects produced by the nervous system upon the sanguiferous system. Dissection has shown that in a large proportion of such cases, the heart and large blood-vessels are either structurally altered or engorged with blood; in some cases, death is clearly referable to effusions upon the brain, and especially at the base of this organ in the neighborhood of the origin of the respiratory nerves.

I have, by numerous experiments upon living animals, demonstrated to the Medical Students of the University, the sudden fatal effects of the arrest of the circulation and respiration, by destruction of the respiratory ganglia, and by the action of such poisons as Hydrocyanic Acid, which act directly upon the medulla oblongata.

The sudden withdrawal of the influence of the medulla oblongata, during fright or excessive joy, may be also assigned as one cause of sudden death.

Numerous examples of the production of convulsions, hysteria, epilepsy, madness and idiocy have been recorded by various writers, as being produced directly and absolutely by fear and terror; but it will be sufficient for the illustration of this subject, to record some instances illustrating the effects over disease of the imagination.

Mr. Coleridge related the following anecdote to Dr. Paris:

As soon as the powers of Nitrous Oxide were discovered, Dr. Beddoes at once concluded that it must necessarily be a specific for paralysis; a patient was selected for the trial, and the management of it was entrusted to Sir Humphry Davy. Previous to the administration of the gas, he inserted a small pocket thermometer under the tongue of the patient, as he was accustomed to do upon such occasions, to ascertain the degree of animal temperature, with a view to future comparison. The paralytic man, wholly ignorant of the nature of the process to which he was to submit, but deeply impressed, from the representation of Dr. Beddoes, with the certainty of its success, no sooner felt the thermometer under his tongue than he concluded the *talisman* was in full operation, and, in a burst of enthusiasm, declared that he already experienced the effects of s benign influence throughout his whole body; the opportunity was too tempting to e lost; Davy cast an intelligent glance at Coleridge, and desired his patient to renew is visit on the following day, when the same ceremony was performed, and repeated ery succeeding day for a fortnight, the patient gradually improving during that eriod, when he was dismissed as cured, no other application having been used.

At the time that Nitrous Oxide excited almost universal attention, several persons ere exceedingly anxious to breathe the gas; and Professor Woodhouse administered them, ten gallons of atmospheric air, in doses of from four to six quarts. Impressed ith the idea, that they were inhaling the Nitrous Oxide, quickness of the pulse, diz-iness, vertigo, tinnitus aurium, difficulty of breathing, anxiety about the breast, a sen-ation similar to that of swinging, faintness, weakness of the knees and nausea, which asted from six to eight hours, were produced; symptoms entirely caused by the breath-ng of common air, under the influence of an excited imagination.

At the commencement of the present century, a man by the name of Perkins, intro-uced certain pieces of metal, called tractors, which he contended would cure certain iseases by merely drawing them over the affected parts. The extraordinary effects hich were said to have been produced by their operation, were referred to galvanic, lectric or magnetic influences.

Dr. Haygarth resolved upon putting the metallic tractors to the test of experiment, nd selecting five patients from the general Hospital at Bath, he submitted them to the peration of a pair of false tractors, composed not of metal but of wood, yet so painted s to resemble the metallic ones in color. The patients thus selected had been ill several onths with various diseases of a chronic character, as gout and rheumatism. Upon he affected parts being stroked in the slightest manner by these pieces of wood, the atients all declared themselves relieved; three of them were particularly benefitted, nd one immediately improved so much in his walking that he had great pleasure in xhibiting proofs of the benefit he had received. One said he felt a tingling sensation or two hours. Similar experiments with wood, slate-pencil, tobacco-pipes, etc., were ade at the Bristol Infirmary with the same results; and the fame attending these ases was so spread abroad, that more patients crowded for relief than time could be fforded to bestow upon them. Men that were unable to lift their arms and legs, were peedily restored to their use, after the application of the supposed metallic tractors.

Such examples explain the miraculous cures ascribed to empirical and inert remedies. t has been well said, "it is the confidence of the quack, and the hope of the patient hich work the cure. Disease is well known to depress the powers of the understanding as ell as the digestion. A sick person is, in particular extremely credulous about the bject of his hopes and fears. Whatever promises him health, may easily obtain his onfidence, and he soon becomes the dupe of quacks and ignorant pretenders."

Dr. Reid has said that he who in the study or the treatment of the human machinery verlooks the intellectual part of it, cannot but entertain very incorrect notions of its ature, and fall into gross and sometimes fatal blunders in the means which he adopts or its regulation or repair. Intellect is not omnipotent; but its actual power over the rganized matter, to which it is attached, is much greater than is usually imagined. he anatomy of the mind, therefore should be learned, as well as that of the body; the tudy of its constitution in general and its peculiarities, or what may be technically alled idiosyncrasies, in any individual case, ought to be regarded as one of the most ssential branches of a medical education.

Plato says: "The office of the physician extends equally to the purification of the ind and body; to neglect the one, is to expose the other to evident peril. It is not nly the body, that by its sound constitution strengthens the soul, but the well regu-ated soul by its authoritative power maintains the body in perfect health."

Hippocrates admitted that, that physician performed most cures, in whom the patients laced the greatest reliance.

Case 56: Epilepsy; Death; Atrophy and Induration of the Cerebellum.

The patient, a young man, died suddenly in an epileptic fit; or rather the patient became comatose after the convulsions and lay in an insensible state for eighteen hours before death.

The cerebrum was normal in its structure and appearance; the cerebellum on the other hand, was atrophied, and the gray and white matter hardened.

The gray matter of the cerebellum was greatly diminished in amount, and the hardening was of the most marked character. A large amount of serous fluid, was effused between the dura-mater and the arachnoid membranes of the brain and spinal cord. The liver, spleen and alimentary canal, appeared to be healthy; but both kidneys were atrophied, being not more than one-half the natural size, with numerous cysts, (containing light yellow fluid), scattered over the surface, and throughout the secreting structures; the surface of the kidneys presented a granular appearance. Both kidneys presented a pale color, more nearly resembling that of fatty degeneration than the normal color. The kidneys have been preserved in the Pathological Department of the Museum, University of Louisiana.

The results of the autopsy in this case are interesting, for in the great proportion of the brains of epileptic patients that have been examined, the structure of that organ has been said to have been in all respects healthy; and this terrible disease has been regarded as merely functional, the particular seat of lesion not being determined.

It must be admitted, however, that in some cases the brain and its membranes have been found in every state of disease to which these parts are liable; the former being indurated, or softened, the seat of various structural diseases, as abscess, cancer or tubercle, the latter being inflamed, thickened or ossified; and Wenzel has stated that the epileptic state has been invariably found associated with a morbid state of the *pituitary* body, in the *cella tursica*.

The occurrence of the epileptiform convulsion in this case, in connection with the marked pathological alterations and degenerations of the kidneys, appear to support the theory of this disease proposed by Dr. Todd. He referred the particular features of epileptic seizures to the general accumulation of a morbid material in the blood from the cessation or impairment of the depurative functions of the kidneys, until it reaches such an amount as to operate upon the brain, as it were, in an explosive manner, exciting a highly polarized state of the brain, or of certain parts of it, so that the nervous power is discharged upon certain other parts of the cerebro-spinal centre, in such a way as to give rise to the phenomenon of fit. A connection has clearly been established between defective renal action, the presence of urea in the blood and epileptic convulsions; and in the present case, the most rational explanation appears to be to refer the fatal convulsions, to the arrest of the eliminative action of the kidneys.

This case illustrates in a striking manner, the importance of a critical examination of the amount, character and chemical constitution of the urine, in each case of epilepsy. Such investigations should not be limited to the paroxysms, but should extend also to the free intervals.

With reference to the treatment of epilepsy, it is important that the physician should make minute inquiry into the condition of all the organs and functions and habits of the patients; and establish the treatment upon correct diagnosis and general principles. Almost every potent agent in the materia medica has been recommended for the cure of epilepsy, and cures have been recorded sustaining the recommendation; but it will be found upon a careful study of the disease, that a certain per cent. of cases, get well gradually and spontaneously without the use of drugs; in females the affection is sometimes connected with derangement of the menstrual function, and when that is regulated, the disease may disappear, without farther treatment; in males masturbation and excessive venery may be causes of epilepsy which are to a certain extent controllable. Some cases are clearly referable to gastric and intestinal irritations and derangements which may be removed or greatly benefitted by treatment; whilst a certain proportion of cases are dependent upon structural alterations of the kidneys, and upon both structural and functional derangements of the cerebro-spinal nervous system, and these march steadily on to insanity, idiocy or sudden death, uninfluenced by the most potent drugs. When epilepsy is clearly the result of the action of the syphilitic poison, the disease may be cured by mercurials and iodide of potassium.

Minute attention to the menstrual function, to the moral and mental habits of the patients, to the state of the digestion and bowels with rigid rules for diet, exercise and sleep, are all important.

Amongst drugs, Bromide of Potassium holds at present a high place with some practitioners; and certainly does good in some cases, but like all remedies in this affection, its action is uncertain, and many cases are wholly uninfluenced by it. In the case of a stout young man, twenty-six years of age, afflicted with epilepsy, and treated in this hospital before the Medical Class, Bromide of Potassium in large and repeated doses were tried, without avail; as much as three drachms (180 grains) having been administered just before a paroxysm, without any perceptible effect. I have employed the Bromide of Potassium, with marked benefit in some cases, whilst in others, no beneficial effects could be perceived. I have employed Bromide of Potassium in my wards, with apparent good effects in the treatment of delirium tremens. Milk punch and nutritious diet were also of great benefit in such cases, for the patients as a general rule had neglected their aliment. A mixture of tincture of Assafœtida, fluid extract of Valerian, and Acetate of Ammonia, had also given satisfactory results in the treatment of delirium tremens.

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In this connection it is important to note that the same kind of changes, characteristic of the cord in Tetanus, viz: distension and dilatation of vessels, exudation of albuminous fluid and extravasation of blood, have been detected in the medulla oblongata in Epilepsy, by Schroeder Van Der Kolk. He directs the attention of the physician, to the condition of the medulla oblongata, in cases of epilepsy; and affirms that he has frequently succeeded, where the disease has not been of long duration in procuring a recovery through derivative applications to the nape of the neck; while the pathological changes resulting from protracted epilepsy are not unfrequently manifested by induration of the *medulla oblongata*.

Professor Schroeder Van Der Kolk concluded his Essay on the Spinal Cord, published by the Royal Academy of Sciences at Amsterdam, in 1854, with the following general conclusions:

> "The medulla oblongata is the principal centre, whence the more general reflex movements and convulsions, derive their origin. I have for years been accustomed to seek in it the starting point of epileptic attacks, and consider that to it the physician should direct his special attention. Even though the primary irritation may be remote, for example, in the intestines, a morbidly elevated sensibility and irritation in the medulla oblongata, always form the foundation of such attacks, and render the organ in question more capable of, as it were, discharging itself in involuntary reflex movements.
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> "An accurate examination of the minute structure of the medulla oblongata, and especially of the pathological changes produced in it by epilepsy of long standing, which I have often observed under the form of hardening, yet in reference to which no microscopical investigations have been made, may still throw much light upon the subject. I have not yet had opportunity to put in execution these investigations, to which I was anxious to direct the attention of physicians.
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> "In this way alone, will it be possible to escape from the unhappy, rude and empirical treatment, which is still so commonly prevalent in reference to epilepsy, and of which I have witnessed so many sad examples. A rational system of treatment of this disease can be based only upon a better acquaintance with the functions of the medulla oblongata, whence we must endeavor more accurately to trace the nature and essence of the disease."

Impelled by the wish to contribute his share in the solution of this difficult question for the advantage of so many unhappy beings, Van Der Kolk applied himself diligently to the investigation of epilepsy, bringing to his aid, in addition to his great skill as an anatomist, and valuable experience as a pathologist, the microscope; and after having

Case 56: Epilepsy; Death; Atrophy and Induration of the Cerebellum.

The patient, a young man, died suddenly in an epileptic fit; or rather the patient became comatose after the convulsions and lay in an insensible state for eighteen hours before death.

The cerebrum was normal in its structure and appearance; the cerebellum on the other hand, was atrophied, and the gray and white matter hardened.

The gray matter of the cerebellum was greatly diminished in amount, and the hardening was of the most marked character. A large amount of serous fluid, was effused between the dura-mater and the arachnoid membranes of the brain and spinal cord. The liver, spleen and alimentary canal, appeared to be healthy; but both kidneys were atrophied, being not more than one-half the natural size, with numerous cysts, (containing light yellow fluid), scattered over the surface, and throughout the secreting structures; the surface of the kidneys presented a granular appearance. Both kidneys presented a pale color, more nearly resembling that of fatty degeneration than the normal color. The kidneys have been preserved in the Pathological Department of the Museum, University of Louisiana.

The results of the autopsy in this case are interesting, for in the great proportion of the brains of epileptic patients that have been examined, the structure of that organ has been said to have been in all respects healthy; and this terrible disease has been regarded as merely functional, the particular seat of lesion not being determined.

It must be admitted, however, that in some cases the brain and its membranes have been found in every state of disease to which these parts are liable; the former being indurated, or softened, the seat of various structural diseases, as abscess, cancer or tubercle, the latter being inflamed, thickened or ossified; and Wenzel has stated that the epileptic state has been invariably found associated with a morbid state of the *pituitary* body, in the *cella tursica*.

The occurrence of the epileptiform convulsion in this case, in connection with the marked pathological alterations and degenerations of the kidneys, appear to support the theory of this disease proposed by Dr. Todd. He referred the particular features of epileptic seizures to the general accumulation of a morbid material in the blood, from the cessation or impairment of the depurative functions of the kidneys, until it reaches such an amount as to operate upon the brain, as it were, in an explosive manner, exciting a highly polarized state of the brain, or of certain parts of it, so that the nervous power is discharged upon certain other parts of the cerebro-spinal centre, in such a way as to give rise to the phenomenon of fit. A connection has clearly been established between defective renal action, the presence of urea in the blood and epileptic convulsions; and in the present case, the most rational explanation appears to be to refer the fatal convulsions, to the arrest of the eliminative action of the kidneys.

This case illustrates in a striking manner, the importance of a critical examination of the amount, character and chemical constitution of the urine, in each case of epilepsy. Such investigations should not be limited to the paroxysms, but should extend also to the free intervals.

With reference to the treatment of epilepsy, it is important that the physician should make minute inquiry into the condition of all the organs and functions and habits of the patients; and establish the treatment upon correct diagnosis and general principles. Almost every potent agent in the materia medica has been recommended for the cure of epilepsy, and cures have been recorded sustaining the recommendation; but it will be found upon a careful study of the disease, that a certain per cent. of cases, get well gradually and spontaneously without the use of drugs; in females the affection is sometimes connected with derangement of the menstrual function, and when that is regulated, the disease may disappear, without farther treatment; in males masturbation and excessive venery may be causes of epilepsy which are to a certain extent controllable. Some cases are clearly referable to gastric and intestinal irritations and derangements, which may be removed or greatly benefitted by treatment; whilst a certain proportion of cases are dependent upon structural alterations of the kidneys, and upon both structural and functional derangements of the cerebro-spinal nervous system, and often march steadily on to insanity, idiocy or sudden death, uninfluenced by the most potent drugs. When epilepsy is clearly the result of the action of the syphilitic poison, the disease may be cured by mercurials and iodide of potassium.

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Impelled by the wish to contribute his share in the solution of this difficult question for the advantage of so many unhappy beings, Van Der Kolk applied himself diligently to the investigation of epilepsy, bringing to his aid, in addition to his great skill as an anatomist, and valuable experience as a pathologist, the microscope; and after having examined the medulla oblongata in not less than fourteen epileptic patients, he brought to bear upon the facts thus established, a thorough knowledge of the important experiments of Brown-Séquard and other distinguished physiologists, upon the cerebro-spinal and sympathetic nervous system.

This observer, in entering on a more accurate investigation of the proximate cause of convulsive movements, directed his attention first to the ganglionic cells, as the parts of the nervous system whence all action proceeds, and which is conveyed through the nerve filaments as conductors to the muscles. These ganglionic cells, which are almost always collected in groups, and are mutually connected, he compared to galvanic or electric batteries, which must be charged to a certain extent before the electricity accumulated in the Leyden jar has acquired sufficient tension to discharge the flash. The discharge in this case is effected, not by a constant stream of fire, but by a sudden spark. Or, perhaps, a comparison with the phenomena in electric fish is still better, when, likewise, a violent discharge takes place, which requires some time, especially when there is any exhaustion, before it can be repeated. There is, however, in these ganglionic cells something peculiar, which is not yet fully explained. Thus they are connected on the one side with nerve filaments, which, as conductors of the orders of the will, are derived from the brain. Through these the ganglionic cells can be immediately brought into action, and the muscle contracts almost at the same moment in which the orders of the will are issued. These ganglionic cells are also connected on the other side with nerve filaments, accompanying the sensitive nerves, which Van Der Kolk has described as reflex nerves. Usually the action does not take place so quickly on stimulating through the reflex filaments, and at least when the ganglionic cells are discharged some time is necessary before the reflex action manifests itself anew. If, however, the action has once begun, the muscular contractions follow rapidly, as in sneezing, swallowing, coughing, etc. The more irritated the condition of the cell now is, the more quickly does the reflex action take place, and the slighter will be the stimulus to the reflex nerves required to produce a reflex action. If the cell is exhausted, some time is necessary, as it were, to charge it again, just like an electric jar, which, if it is discharged by a spark, must be charged afresh before it can again exhibit the same electrical phenomena. Van Der Kolk does not attempt to offer any satisfactory hypothesis in explanation of the fact that the orders of our will act otherwise on these ganglionic cells, so that we can maintain a muscle for a long time in a state of strong or weak tension, while, in reflex action, the power of the cell is exhausted in a moment, and the action ceases for a shorter or longer period. It is enough, he says, that experience proves its truth, and we must therefore receive it as an unexplained fact, and infer that the action of the reflex nerves on the ganglionic cells differs from that of the orders of our will. He suggests, however, that the cause may exist in the peculiar nature and action of the reflex cells; since, if our will acts directly on these reflex cells, as in swallowing, the action rapidly interrupted, is performed by way of discharge. It has, however, been clearly ascertained, that for the restoration of this activity a certain quantity of arterial blood is required, on the effect of which on the ganglionic cells their capability of action depends. It is indeed true that we see convulsive movements ensue also after loss of blood in hæmorrhages; but here Van Der Kolk conceives that so many causes co-operate to produce a change in the cell, that we are not in a state to follow with sufficient accuracy the whole course of active causes and effects in their several relations, and to watch nature everywhere in her hidden agencies. Quite in accordance with this view is the great number of blood-vessels which are present in the gray substance of the spinal cord and brain, in comparison with the so-called white or medullary matter, which consists of conducting filaments. Nowhere did Van Der Kolk find the quantity of capillary vrssels so great, and presenting such a dense, interwoven tissue as in the corpus ciliare of the corpora olivaria; this body, in fact, affords one of the most beautiful capillary net-works to be met with in the system, the vessels existing here in much greater number than in the gray cornua of the spinal cord itself. Thus also it has been observed that the other groups of the ganglionic cells occurring n the medulla oblongata, as those of the hypoglossus, vagus, etc., with the accessory or uxilliary ganglia, are uncommonly rich in blood-vessels.

From these facts the inference was deduced, that more arterial blood flows in the ganglionic groups of the medulla oblongata, and thus also a more active metamorphosis f tissue takes place there, than in the gray horns of the spinal cord. Whilst admitting the great vascularity of the arbor-vitæ of the cerebellum, and of the thalami and corpora striata, he does not include these parts in his explanation of the phenomena of Epilepsy, because he was at that time unacquainted with their use; and whilst it must be admitted that many points relating to the functions of these important portions of the nervous system are not yet settled, still sufficient is known from the results of direct physiological experiments upon various portions of the brain, to show that these portions are involved, if not primarily, at least secondarily in Epilepsy.

It is evident that the vascularity of the ganglionic groups, and the quantity of arterial blood supplied to them, are directly related to the intensity of their action. The capacity for reflex movements is thus promoted by a strong arterial afflux of blood, which increases the vital actions of the ganglionic cells; as, however, the ganglionic groups in the medulla oblongata receive the most vessels, the reflex movements should also, by preference take place here; and this again agrees with the function, for example, of the corpora olivaria, whereby such different reflex movements as we observe in no other part of the nervous system, are produced, or with the constant reflex movements, which are incessantly developed from the vagus on the lateral columns of the medulla, for regular breathing. Van Der Kolk hence infers that, other things being equal, where there is general excitement of the vascular, an increased activity of the nervous system, involuntary reflex phenomena should, perhaps, after the application of a slight stimulus, first arise in the part in which vascularity is greatest, and where the natural capacity for reflex phenomena is strongest, namely, in the medulla oblongata. And he regards this extremely probable conjecture as having been converted into certainty, by the important experiments of Brown-Séquard.

Thus, Brown-Séquard found, that if he injured the spinal cord in mammalia, especially by cutting through one-half of the cord, or the posterior columns and posterior horns of the gray substance (wherein, as Van Der Kolk has shown, that very fine longitudinal fibres exist, which appeared to serve to unite in an harmonious movement the reflex impressions on severally distinctly situated ganglionic groups), and if the animal survived this dangerous operation, after the lapse of three weeks, convulsive movements were excited, quite agreeing in every respect with epileptic attacks, at the same time the very remarkable phenomena was observed, that if the left side of the spinal cord was cut through at any spot between the seventh or eighth dorsal and the third lumbar vertebra, it almost invariably followed that stimuli applied to the left side of the face, occasioned convulsive movements, while, if applied to the right side, they by no means had this effect.

This capacity for reflex movement did not manifest itself until after the third week from the receipt of the injury. The convulsions extended over the whole body, with the exception of the part paralyzed by the transverse section, and were, consequently, not unilateral. After some time these convulsions again ceased, and were subsequently repeated. The convulsions sometimes arose spontaneously, without any external stimulation; but among all parts of the body, there is only one where slight irritation was sufficient to excite them, namely the side of the face, or as was subsequently more particularly shown by Brown-Séquard, of the cheek. The space in question was bounded above by a line drawn from the eye to the ear; anteriorly, by one drawn from the eye straight down to the under jaw; and inferiorly, by one passing from hence to the ear, and the lateral parts of the neck, sometimes even to the shoulders; it consequently corresponded to the region supplied by the second and third branches of the trigeminus. If only one side of the spinal cord was cut through, only one cheek was capable of exciting these convulsive or epileptic movements, and the other cheek might be irritated with impunity, and pinched without any result. But if both posterior columns were cut through, the symptoms were occasioned by irritating either one or the other cheek. These experiments led to important conclusions.

In the first place, this capacity for convulsive movements did not take place until the third week after the infliction of the injury, and then originated in the medulla oblongata, which is far removed from the injured part. Van Der Kolk hence inferred that the irritated condition developed by the injury of the inferior dorsal or lumbar portion of the spinal cord, extended slowly upwards to the whole cord, and particularly to the medulla oblongata. Indeed, he affirms that these convulsions could be excited by irritation only from the medulla oblongata, through the nervous trigeminus, and probably through the accessory. This is still further confirmed by the course of the convulsions themselves. Thus the first convulsive movements which arose, were confined to spasms of the face and of the eyes; some days after this first attack, the muscles of the larynx, neck and chest were affected with convulsions, and finally, the muscles of the trunk and extremities participated in the movements. One of the first phenomena of a complete attack, consisted in a spasm of the glottis, or of the muscles of respiration.

Brown-Séquard has thus, by his experiments, produced an exact picture or manifestation of a violent attack of Epilepsy, with all its symptoms, in the order in which they occur in an epileptic patient.

It is important to observe in the foregoing experiments, that after an injury of the dorsal or lumbar portion of the spinal cord (there is no doubt that injuries of higher parts of the spinal cord would produce the same phenomena, but these affect the life of the animals so much that they die before this change in the medulla oblongata has occurred), the exalted reflex phenomena do not exhibit themselves in irritation of that part of the cord which is situated next the wound, and which we should expect to be first and most violently affected by the application of the stimulus. But the phenomena exhibit themselves first in the medulla oblongata, where the part commences to participate in the general morbid excitation of the spinal cord, occasioned by the injury. And even then, irritation of the inferior portion of the cord is not competent to excite these convulsions, but according to Brown-Séquard, only irritants, directly applied to the medulla oblongata are capable of producing such effects. Even irritants applied to the paralyzed foot, which on unilateral section of the spinal cord, changes into a condition of hyperæsthesia or increased sensibility, do not produce these convulsions.

Van Der Kolk points out the agreement of these investigations by Brown-Séquard, with the results previously deduced by Pflüger, from a great number of observations, his conclusion being that, on irritation of a sensitive nerve of the brain, (*trigeminus*), the progress of reflex movements is downwards, or towards the medulla oblongata, while, on irritation of a spinal nerve the progress of reflexion is inverted, from below upwards, that is, likewise towards the medulla oblongata. Hence, if the reflexion occurs in the motor nerves lying even very distant from the irritated sensitive nerve, the reflectorally excited motors are always such as arise from the medulla oblongata; and it is therefore not until the irritation has reached the medulla oblongata, that the reflex movements can pass to the other side and extend over the whole body. But if the irritation of the medulla is not too great, it may, when it has reached the medulla oblongata, extend over the body, but not on the same side. Cousequently, a higher degree of irritation is necessary for the transferrence of the spasms to the opposite side, than for their extension on the affected side; therefore, tetanus is a result of a greater irritation than that by which intermittent spasms are excited. From all this, it is clearly seen, both that the medulla oblongata is distinguished by a greater sensibility to irritation, and also, that this is the situation where bilateral convulsions originate; but thus we must regard the medulla oblongata as the proximate starting point in convulsions, such as those which occur in Epilepsy and other nervous affections; and that in the majority of cases, the most violent action takes place on the side whence the irritation of the spinal cord or from the brain has proceeded.

While the medulla oblongata is particularly rich in blood-vessels, because an abundant current of arterial blood is required during its increased activity; on the other hand, in reflex movements, its activity is commonly rapidly exhausted, and the convulsive motions set at rest;—to begin again subsequently, or to be continually repeated. The experiments of Brown-Séquard have shown, that after the infliction of a wound in the inferior part of the spinal cord, a certain morbid condition has been slowly developed; that is, inflammation has arrived, as a necessary result at the seat of injury, and a state of exalted sensibility has gradually been communicated to the entire cord, and finally to the medulla oblongata; and although the exciting cause, the irritating wound inflicted on the spinal cord, and the more excitable state of the medulla oblongata so produced, are constant, the phenomena are nevertheless intermittent.

From a great number of clinical facts, it has been shown, that to produce epilepsy, no disorganization is necessary, no great change in the tissue, but only increased excitability, and commonly augmented determination of blood and chemical change is required. But it is not necessary in order to excite this exalted capacity for reflex action in the medulla oblongata, that this stimulus should always be applied through a spinal nerve, the sympathetic and the vagus effect the same; thus, in children, convulsions arise from the irritation of teething, as well as from worms, acidity, exalted intestinal sensibility, and inflammation of the intestines, when the dilated pupil, sufficiently indicates the exalted activity of the sympathetic, under whose control the dilator of the pupil is placed. Thus a stimulus applied to the sympathetic or vagus, from the stomach and intestines, acts as much in increasing the sensibility and activity of the medulla oblongata, as inflammation in a spinal nerve.

But these causes are not so limited; thus through the abundant supply of blood, must the vital metamorphosis of tissue, and with it, the organic activity in the medulla oblongata, as in all parts of the body be kept up; but if the blood itself be diseased, if it has deviated from its healthy composition, it no longer supplies the normal stimulus; it no longer furnishes the nutritive matters in the state in which they are required for the maintainance of the vital functions. Thus, all kinds of convulsions and nervous attacks, even epilepsy, arise from chlorosis, in which iron or hæmatin appears to be deficient, and the lymphatic blood globules predominate. By the administration of ferruginous preparations, and by good feeding, all the nervous phenomena cease, and even the epilepsy may be dissipated. The same thing is seen in the administration of strychnia, when the blood is poisoned by the absorption of this powerful agent; but although strychnia, which is taken up into the blood, circulates in it, and therefore comes in contact and interchange with the medulla, the phenomena are not persistent, but manifest themselves in intermittent spasms. Hence, it follows, that in these violent spasms and exalted capacity for action, which, with strychnia, is not confined to the medulla oblongata, the ganglionic cells are more or less rapidly exhausted; that is, a change takes place in the cells, which must be counteracted by fresh nourishment, and by the influence of a copious stream of arterial blood. It is, therefore, not until the exhausted irritability is restored by some rest, that the capacity for reflex action, or the radiation of power, once more attains the heighth, at which only a slight stimulus, or even no external stimulus is required to excite convulsions.

The same thing is true of epilepsy. It is a well known fact, which has been frequently observed, that if an epileptic patient has been attacked by a severe fit, he remains proportionally much longer free; but if he has had only a slight attack, this is repeated after a shorter time, often on the following day, in a more violent form, and now again the patient continues longer exempt. Even the exalted irritability of the nervous system, and especially in the medulla oblongata, and in the brain, which are reciprocally so closely connected, manifests itself in the epileptic patient before the attack, very often by greater restlessness and increased tendency to passions, and sometimes in an unpleasant sensation, from which the sufferers are again delivered for a time, by the more or less rapid occurrence of the fit.

It seems to be scarcely doubtful that the excited action of the ganglionic cells in the medulla oblongata must extend its influence to the vaso-motor nerves of the brain, and this altered, or more or less disturbed state of the circulation is, in the opinion of Van

Der Kolk, the cause of the loss of consciousness during an attack of epilepsy; while it is incorrect to suppose that this loss of consciousness always precedes the attack. He freely admits, with Kussmaul, that in an epileptic attack the whole brain participates more or less in the change; but the commencement of the fit, or of the discharge, must be referred to the medulla oblongata. In like manner, this pathologist explains the loss of consciousness as the result of the action so produced on the walls of the vessels of the brain, while consciousness may in some slight attacks even be maintained, or the may be lost without convulsions being produced.

We have thus presented in full the theory of Epilepsy, so ably developed and supported by Van Der Kolk.

From a careful investigation of the Pathological Anatomy of Epilepsy, Van Der Kolk arrived at the following conclusions:

That the first cause of Epilepsy consists in an exalted sensibility, and excitability of the medulla oblongata, rendering the latter liable to discharge itself on the application of several irritants which excite it in involuntary reflex movements. This irritation may either be external, (irritation of the trigeminus), an irritated condition of the brain, or, as is still more frequent, it may proceed from irritants which excite it, in involuntary reflex movements, as from irritants in the intestines. In children, worms in the intestines, acidity, a torpid state of the bowels, etc., are among the most common causes; in adults there may be irritation of the intestines, particularly of the mucus membrane, constipation of the colon, connected therewith, but above all, onanism, which acts so very much on the medulla oblongata, and must be regarded as a very frequent cause of Epilepsy. Amenorrhœa, chlorosis, plethora of the uterus, hysteria, etc., are also to be enumerated.

In the commencement there is still only exalted sensibility. If this can be removed or moderated, the Epilepsy gives way of itself, especially if the sensibility is not renewed by remote causes.

But if the disease has already lasted long, organic vascular dilatation takes place in the medulla, the consequence being that too much blood is supplied, and the ganglionic groups are too strongly irritated, and too quickly overcharged. Every attack then becomes a renewed cause of a subsequent attack, and the vascular dilatation is afresh promoted by every fit. In the commencement of Epilepsy, therefore, it would seem that no apparent organic change exists. Rapidly, however, probably in consequence of the repeated congestion, the presence of a more albuminous fluid between the nerve filaments is manifested, which may first cause more or less hardening, and may subsequently give rise to fatty degeneration and softening. In addition, dilatation of the arterial capillaries, and thickening of their walls ensue.

These blood-vessels in the medulla oblongata run chiefly in the region of the hypoglossus and vagus, as well as in the septum, and in the corpora olivaria. The posterior half of the medulla oblongata in epileptic subjects, appears on a transverse section, redder and more hyperæmic than in the normal state, whether the sufferers died during an attack or not.

Epileptics may be divided into two classes: Those who bite their tongues during the fit, and those in whom this never, or extremely rarely occurs. In the former, the capillary vessels are usually wider in the course of the hypoglossus and corpora olivaria; in the latter, in the course of the vagus. In these last, the disease is, on account of the greater tension in the organs of respiration, more dangerous, and the patients die during a fit, most frequently in consequence of arrest of respiration, which appears to occur less frequently in patients of the first class.

This increased vascular dilatation, with thickening of the walls, whereby the afflux of arterial blood is augmented, and the ganglionic cells are more rapidly charged, and the altered exudation of intercellular fluid, appear to constitute the proximate causes of the incurability of many long-standing cases of Epilepsy. Lastly, increased exudation of albumen ensues from the now constantly distended vessels, whose walls at the same ne become thickened, producing increased hardness of the medulla, subsequently ssing into fatty degeneration and softening, and rendering the patient incurable.

With these changes, vascular dilatation of the brain, and particularly in the cortical bstance, goes hand in hand. The small ganglionic cells, which are here present in ch abundance, become compressed by the dilated vessels, and perhaps also in conse- ence of the more albuminous nature of the intercellular fluid. Dullness and loss of mory are the results; or if after a fit, an unusual current of arterial blood is sup- ed, we have, following immediately upon the paroxysm, over-irritation, rage and ute mania, which is present in so many epileptics. This dullness of the mental wers, which may represent apparent, until it finally passes into true dementia, differs ry much from dementia after acute, or chronic mania—a point which is not suffici- tly kept in view. Dementia after epilepsy is for a long time the result of vascular latation, and if we succeed in conquering the Epilepsy, the silliness, the blunting of e mental powers, and the shortness of memory give way, and the patient gradually gains his former powers of mind, although not always in a perfect degree, which pends on the amount of the affection. The dilatation of the vessels, kept up by fresh attacks and convulsions, begins by degrees to disappear, the vessels contract, gain their tone, the albuminous exudation becomes absorbed, and the patient covers.

In cases, however, of dementia after acute mania, the state of things is quite differ- nt. Here the affection begins with irritation of the cortical substance, especially of e anterior lobes, under the os frontis; this passes under the form of chronic menin- itis, which manifests itself, only by increased excitability of the patient into inflamma- ion.

The sufferers from mania have no great prospects; they have become rich, play with illions, are generally kings and emperors, prophets or embassadors from heaven. here then ensues a formation of cells and granular cells, and the cortical substance ecomes firmly adherent to the pia-mater. The blood-vessels become atheromatous; ith meningitis, effusion of much serum ensues; the vessels exude a more watery fluid, nd the cortical substance begins to atrophy. It becomes paler and thinner, and true ementia, which is absolutely incurable, follows the previous excitement.

Thus, although the phenomena may be the same, as in both cases, there is compres- ion of the cortical substance, the latter, after mania and the co-existing inflammation, asses rapidly into degeneration, and the disease becomes incurable; while in Epilepsy, he vascular dilatation, which is only occasionally promoted by an attack, may last for long time without producing active degeneration. Patients have completely recovered rom a high degree of silliness and dullness in consequence of Epilepsy. In patients pileptic in a very slight degree, where absence of mind took place, almost alone, with- ut convulsions, where, therefore, the brain was more directly affected than the medulla blongata, stupidity, diminution of memory, incapability of continued thought, or of omprehending anything, arose much more rapidly than in those cases where spasms ere constantly repeated without loss of consciousness. Accordingly, the longer the leep lasts after each attack, and with it, the severe congestion of the cerebral vessels ontinues, so much the more injuriously does epilepsy act on the mental powers, so uch the more does dullness ensue.—(Professor Schroeder Van Der Kolk, on the inute Structure and Functions of the Spinal Cord and Medulla Oblongata, and on he Proximate Cause and Rational Treatment of Epilepsy; Trans. by W. D. Moore, ew Sydenham Soc., London; 1859; pp. 80, 207, 208, 205–218, 221–226, 230–250, 51, 252, 283, 284, 285).

The main points of agreement or disagreement, between the views and theories of an Der Kolk and Brown-Séquard, may be gathered by the comparison of the obser- ations of the former, just recorded, with the following brief analysis of the labors and iews of the latter, as contained in his *Researches on Epilepsy*, published in the Boston edical Journal, November 1856 to November 1857.

Dr. Brown-Séquard deduces the following conclusions from his experiments, upon the artificial production of Epilepsy.

1st. That an injury of the spinal cord, may give rise to an epileptiform affection. 2d. That there is a relation between certain parts of the spinal cord, and certain branches of a portion of the nerves of the face and neck. 3d. That epileptiform convulsions may be the constant effect of slight irritations of certain nerves. 4th. That even when an epileptiform affection has its primary cause in the nervous centres, some cutaneous ramifications of nerves not directly connected with the seat of injury in these centres have a power of producing convulsions, when other nerves even directly connected with them, have not. 5th. That the ramifications of certain nerves may have the power of producing convulsions, while the trunks of the nerves have not this power.

In regard to the division of Epilepsy, into *centric* and *peripheral*, Brown-Séquard endeavors to show that even in cases where the disease appears, most certainly, to be of peripheral origin, it may sometimes be, in reality, of centric origin. To determine the fact during the life-time of the patient, is often impossible.

Dr. Brown-Séquard, adduces a number of observations from different writers on nervous diseases, which would seem to show that, in the human subject, the peculiar disturbances of the cerebro-spinal axis, which constitutes epilepsy, may be generated by alterations of different parts of this nervous axis, and by many nerves; and arrives at the conclusion that the seat of Epilepsy is very various. Usually the first spasmodic contractions occur, in the muscles of the larynx, of the neck, of the eyes, of the chest, of the face, and in the blood-vessels of the brain proper, showing that the disease is ordinarily seated in the encephalon, or upper portions of the spinal cord, or in both. But that its seat, may also be in other portions of the spinal cord, would seem to be proved by the occurrence of the first spasmodic contractions in one of the limbs, either the inferior or superior. After the first spasms, all the muscles of the body may be attacked with convulsions; so that if loss of the actions of the brain proper, be alone regarded, there is ground for thinking that the seat of the disease, is both in those parts of the cerebro-spinal axis, where reside the faculties of perception and volition, and in those endowed with the reflex faculties; but according to Dr. Brown-Séquard, this view is correct only in appearance. Thus he attempts to show, that the loss of perception and volition, does not prove, that epilepsy has its seat in the brain proper, but that it is highly probable, that a contraction of the blood-vessels of the brain proper, due to an irritation of their nerves in the spinal cord and medulla oblongata, causes the loss of the cerebral faculties; and as regards the increase of the reflex faculty, a partial and local increase, is sufficient for the production of fits.

Dr. Brown-Séquard believes that Epilepsy is always the result of an excitation of the cerebro-spinal axis. This excitation he supposes, may, in some cases, arise from chemical and physical changes occurring in the elements of the nervous centres in consequence of bad nutrition, and other causes.

In regard to the production of Epilepsy by a poison in the blood, Dr. Brown-Séquard admits that such may be the case, when the functions of the kidneys, liver, skin or other depurative organs are suspended, and, in consequence, certain deleterious matters are allowed to accumulate in the blood, and also in cases where poisonous substances are admitted from without, as lead, strychnine, Cyanhydric acid. Nearly all of these latter poisons act only as causes of convulsions by increasing the reflex faculty of the cerebro-spinal centre—they give to the nervous centres, the faculty of causing convulsions *when they are irritated, but they do not irritate.* He knows of no poison which causes convulsions, by a direct irritation of any part of the nervous system, excepting carbonic acid, when it is allowed to accumulate from any cause in the blood. While it seems to destroy the reflex power of the cerebro-spinal centre, the decarbonized blood at the *same* time, irritates violently this centre, and therefore causes directly powerful convulsions.

While he admits that in epilepsy, there is very generally, perhaps always an increased reflex excitability, with or without an increased reflex force, he recognizes also, that

great many cases of epilepsy, a special kind of excitation acting on the
res.

to Brown-Séquard, there are therefore three distinct elements for the pro-
fit: 1st, Increase of the force of the reflex property; 2d, Increase of the
of this property; and 3d, An excitation of a special nature, or of a very
Of these three elements, the last two are the most frequent, and perhaps,
hese two is essential.

n-Séquard, thus explains the paleness of the face, the spasm of the larynx,
of consciousness, which either one, or all of them, usually present them-
e commencement of the epileptic paroxysm.

excitation takes place in the spinal cord, and the basis of the encephalon,
rise to the fit, the nerve fibres, which go to the head, are irritated and pro-
action of blood-vessels. Of course this contraction expels the blood, and
nce the face becomes pale. Very often, another effect, depending on the
of the cervical sympathetic is produced—the dilatation of the pupil. But
sometimes takes place—a contraction of the pupil occurring instead of a
This last phenomenon is easily explained, by admitting that the excitation
us centres takes place near the origin of the third and fifth pair of nerves,
hat of the cervical sympathetic, as is the case when the pupil dilates. The
the face, and the dilatation of the pupil when it exists soon disappears,
nsequence of the obstacle to the venous circulation in the head, and of the
yxia. The cause of the obstacle to the return of the blood from the head, is
contraction of the muscles of the neck, as Dr. Marshall Hall seems to think,
state of the chest. Among one of the first symptoms of the fit, and as a
cry, there is a spasm of the laryngeal muscles, and a contraction of the
nuscles. This contracted state of the chest acts on the heart, so as to
force of its beatings, as is the case in the experiment of compressing the
by E. Weber and others, and it acts on the veins in preventing the circula-
m. Although compressed, and unable to beat freely, the heart quickly
apparently great strength; the blood losing its oxygen and becoming black
werful irritant upon the central organ of circulation, so that palpitations,
ery violent occur. Nevertheless the pulse often remains weak, because the
blood sent to the arteries by the heart is smaller than usual, partly on
the venous circulation.

vn-Séquard, thinks that at nearly the same time, when the origin of the
the sympathetic nerve going to the blood-vessels of the face receive an irri-
beginning of a fit of epilepsy, the origin of the branches of the same and
going to the blood-vessels, of the brain proper, also receive an irritation.
on then occurs in these blood-vessels, and particularly in the small arteries.
ction expelling the blood, the brain proper loses at once its functions, just as
complete syncope. Now as it has been well proved by the researches of
rcrombie, John Reid, Henle, and Folitz, that the quantity of liquid, in the
l cavity, cannot change suddenly, it results that if there is less blood in the
r, there must be more in the basis of the encephalon, and in the spinal cord.
nce of the impediment to respiration, the blood sent to the encephalon, as
ther parts of the body, contains but little oxygen, and is charged with car-
so that the large quantities of blood accumulated in the basis of the
—the medulla oblongata, the pons varolii, the tubercula quadrigemina, etc.,
spinal cord, is endowed in a high degree with the power, which Brown-
s shown that such blood possesses; i. e. to excite convulsions. It may be as
supposed, that the basis of the encephalon, is also excited to cause convul-
nsequence of the pressure exerted upon it, by the accumulation of blood.
cord also in all its length, is then excited to produce convulsions by the
h circulates in it.

équard illustrates, by means of the following table, the mode of production and the interchangement and sequence of the most interesting phenomena of a complete fit of Epilepsy.

CAUSES:	EFFECTS:
1. Excitation of certain parts of the Excito-motory side of the Nervous System.	1. Contraction of the blood-vessels of the brain, proper, and of the face, and tonic spasm of same muscles of the eyes and face.
2. Contraction of the blood-vessels of the face.	2. Paleness of face.
3. Contraction of the blood-vessels of the Brain proper.	3. Loss of consciousness, and accumulation of blood in the base of the encephalon and in the spinal cord.
4. Extension of the Excitation of the excito-motory side of the nervous system.	4. Tonic contractions of the laryngeal, the cervical and the expiratory muscles—laryngismus and trachelismus.
5. Tonic Contraction of the laryngeal and of the expiratory muscles.	5. Cry.
6. Farther extension of the excitation of the excito-motory side of the nervous system.	6. Tonic contractions extending to most of the muscles of the trunk and limbs
7. Loss of consciousness and tonic contractions of the trunk and limbs.	7. Fall.
8. Laryngismus, trachelismus, and the fixed state of expiration of the chest.	8. Insufficient oxygenation of the blood, and general obstacle to the entrance of venous blood in the chest, and special obstacle to the return of the blood from the head and spinal canal.
9. Insufficient oxygenation of the blood, and many causes of rapid consumption of the little oxygen absorbed, and distribution of venous blood in the nervous centres.	9. Asphyxia.
10. Asphyxia, and perhaps a mechanical excitation of the base of the encephalon.	10. Clonic convulsions everywhere; contraction of the bowels, of the bladder; of the uterus; erection; ejaculation; increase of many secretions, efforts at inspiration.
11. Exhaustion of nervous power generally, and of reflex excitability particularly, except for respiration. Return of regular inspirations and expirations.	11. Cessation of the fit; coma or fatigue; headache; sleep.

We have thus endeavored to present with accuracy and minuteness, the most important results of the labors of Schroeder Van Der Kolk and of Brown-Sequard.

Whilst Marshall Hall treated of epilepsy, as an affection of the medulla oblongata, he failed to point out the distinctive pathological changes characteristic of epilepsy, and the various diseases of the nervous system, which he classed with it, as apoplexy, paralysis and mania: Van Der Kolk, on the other hand first investigated and disclosed the organic changes undergone by the nervous system in epilepsy and mania, and thus placed the pathology of convulsive diseases, upon a firm and scientific basis. Such labors reflect light upon all the various affections of the cerebro-spinal nervous system, and they especially furnish material of the greatest value for comparison, and especially for the elucidation of Traumatic Tetanus.

The recent investigations of M. Gonzalez Echeverria, have sustained the accuracy of the pathological observations of Van Der Kolk, and he has been led to embrace a theory of the disease, which does not differ materially from that of Van Der Kolk, viz:

> "That epilepsy is a disease constituted by chronic paroxysms, excited upon a direct or reflex action of the medulla oblongata, in a condition of exalted irritability, co-incident with sudden depression of the cerebral circulation and with loss of consciousness, with or without muscular spasm. The medulla oblongata is the original seat of epilepsy and the disease primarily involves the vaso-motor nerves."

Dr. Echeverria, bases his views of the pathology of epilepsy, upon twenty-six autopsies of epileptics.

The observations of this pathologist upon the lesions of the sympathetic are important. Granular degeneration, irregularity, and pigment infiltration of the cells, in addition to more or less hyperplasia of connective elements, prevailed in the sympathetic, reflecting, as it were, the influence of the disturbance, giving rise to the modifications in the other nervous centres. Dr. Echeverria, is inclined to consider such change, as a primary and not as a consecutive derangement, for it is not the less the fact that it has appeared in every instance, and more constantly than the cerebral alterations. The propagation from the fourth to the third ventricle, corpora striata, and cortical substance, frequently noticed, seemed to follow up the tract of sympathetic fibres in the brain, which may be perhaps, the first to be disturbed in this organ. The sympathetic was examined in fifteen cases of epilepsy, and in each case, a more or less impaired state of the cervical ganglia was detected; and not unfrequently, there was a conspicuous similarity between the injured ganglionic cells and those of the medulla, or in the middle and between the cornua of the spinal gray matter. Whilst admitting with Jacubowitsch, that sympathetic cells are located in these regions, yet Dr. Echeverria did not derive from his pathological observations, sufficient evidence to ground the opinion, that the sympathetic suffered more damage than any other cells, or that those in the spinal cord, so hurt, were mainly sympathetic cells. Neither did he arrive at distinct results every time; on investigating the net-work or nervous plexus around the cerebral arteries, participating in advanced cases of the degeneration in the arterial parietes, and displaying proliferation of nuclei, in their attenuate primitive fibres. This observer attributes the absence of cadaveric rigidity and earlier putrefaction of the paralyzed muscles, in cases of epilepsy, attended with paralysis, to the lesion of the sympathetic. The fact is principally exhibited by the muscles of the paralyzed limb, which are affected with permanent contraction. Similar observations have been made by Charcot and Bouchard.

Changes were discovered in the ganglionary roots and peripheral extremities of the dorsal nerves, in a case in which a herpetic eruption of zoster encircled the base of the breast.

The ganglia presented their cells reduced to a mass of pigment deposited in the granular contents, with an exuberance of connective tissue and nuclei, which did not exist so much in the other regions. As to the nerves connected with the eruptive patches, they had undergone a fatty degeneration of the primitive fibres, with the same rank growth of connective elements. The blood-vessels in the vicinity of these spots exhibited a marked amyloid degeneration. Similar changes were observed in the ganglia and peripheral nerves of four other cases attended with eruptions and modifications of the skin commonly observed with epileptics. These phenomena are in accordance with those pointed out by Recklinghausen and Baerensprung, in the case of an infant with unilateral zona on the breast; more recently, Charcot and Cotard had likewise reported a case of alteration (neurits), of the right cervical plexus, and corresponding spinal ganglionic roots, attended with zona on the same side of the neck.

Dr. Echeverria refers these and other disturbances to the sympathetic, and expresses his firm belief that the circulatory system is especially concerned in the pathology of Epilepsy. Thus, he says:

> "There appears from the onset of the epileptic disease, a disturbed action, and whether due to the slowness, or complete stoppage in the supply of blood, or to a primary trouble in the nervous elements, it soon brings a structural modification of the blood-vessels. And it is not less positive that the metamorphosis commences with paralysis and dilatation, and closes with a retrograde or fatty degeneration of the blood-vessels. I assert that so far as I have had opportunities to judge, the dilatation is mainly the result of paralysis, and not of partial contraction in the calibre of the blood-vessels, on account of the lengthening associated with it, which could proceed only from a lack of tonicity in the vascular walls. Even when a thrombus or migratory clot obliterates an artery, causing stagnation of blood, the aneurismal dilatation acknowledges as cause, in great part, the weakening of the vascular walls. However, in this latter circumstance, there are two more important elements to take into account; the increased tension of blood, in consequence of the obliteration of the vessel, and the reflux of venous blood from want of *vis-a-tergo* in the artery, as imagined by Virchow. To the impediment in the local circulation must be referred the circumscribed abnormalities

in the structure of the nervous centres, and the thickening or growth of granulations and adventitious patches in the cerebro-spinal membranes. These adventitious deposits do not belong, as generally supposed, exclusively to old age. I have not seldom encountered them in individuals dying in the prime of life from epilepsy or other cerebro-spinal affections."—(On Epilepsy, Anatomic, Pathological and Clinical Notes, etc., New York; 1870, pp. 111-178).

It would be foreign to my purpose to enter into any critical examination of the various views which have been propounded, with reference to the nature and causes of epilepsy; the preceding analyses of the labors of those observers who have most fully investigated the natural history of this disease by microscopical, anatomical, physiological and pathological inquiries, fully sustain the proposition, that in epilepsy distinct and recognizable lesions have been detected in the cerebro-spinal and sympathetic nervous systems. The following cases will, in like manner, establish the existence of *structural* lesions of the nervous system in various forms of paralysis:

Case 57: Loss of Muscular and Nervous Power—Paralysis—Death; Structural Lesions of Nervous System.

The history of this case resembled, in some respects, that of the succeeding; the subject being, in like manner, a negro man, (aged 50 years), who had been working during the last two years upon a rice plantation, his duties compelling him to stand in water above his knees. Previous to this occupation, had been a healthy, stout man.

During the spring months, he began to suffer from "rheumatism in the left knee," which extended to left elbow, and right knee and elbow, and the use of the extremities was gradually lost. The paralysis appears to have begun in the lower extremities, and the lower extremities were said to have been œdematous before being paralyzed.

In the month of August the power of locomotion was lost, and the patient became bed-ridden.

The œdema of the lower extremities disappeared during rest; the rheumatic pains, however, have continued to harrass the patient up to the present time, and the muscles of the extremities have gradually emaciated, until they are now much reduced in size. Has had no trouble in defecation or urination.

At the present time, skin warm and moist; temperature of axilla 99°.5, and patient lies on his back; subsultus tendinum, and pains in the shoulders, the former only occasionally, the latter persistent; paralysis of upper extremities, flexors of left arm partially contracted, paralysis of extensors of left arm more complete than in right; extensors of lower extremities unaffected; flexors paralyzed; tongue slightly furred; appetite good; bowels regular; respiration regular, about twenty per minute; pulse seventy-two, small.

The treatment has consisted of Iron and Strychnine, and the patient has gradually improved since his entrance into the hospital, and the power over the voluntary muscles appears to be slowly returning. As in the succeeding case, this patient had been exposed to the action of malaria, and to cold and wet, in a low, unhealthy region; and in like manner the gradual loss of power in the extremities, was preceded and accompanied by rheumatic pains, which were more decided, and attended with more marked local inflammation; in like manner there is asthenia, with no loss of sensation or intelligence. It appears to be reasonable to refer the nervous derangement to the same causes in both cases.

The paralysis progressively increased, until the patient became utterly powerless, and was confined to bed.

The flexors of the fore-arm were firmly contracted; and the muscles of the fore-arms and legs wasted considerably. Strychnine and Iron appeared to accomplish no good in this case, and death occurred March 31st, 1869. Up to the time of death, there was no alteration of sensation, notwithstanding the paralysis of motion.

Autopsy, five hours after death.—The brain and spinal cord were carefully removed. The gray matter of the brain and spinal cord was of a deep reddish gray color. Blood-vessels of arachnoid and pia-mater congested with blood. The arachnoid of the medulla oblongata and superior portion of the spinal cord was discolored, presenting the appearance as if it had been washed over with a weak solution of the Nitrate of Silver. Spinal cord somewhat atrophied, with the white matter firmer than usual, and the gray matter softened.

The brain and spinal cord of a patient that had died with phthisis pulmonalis were removed and compared with the one under consideration, and it was observed that it was far lighter in color; and it was especially observed that the gray matter of both the brain and spinal cord were far lighter. Spleen somewhat enlarged and softened. Liver of slate and bronze color, with a patch of incipient fatty degeneration.

Microscopical Examination of Nervous Structures.—The colored portions of the spinal cord were due to a deposit of coloring matters in the form of granules or crystalline masses in and around the meshes of the blood-vessels of the dura-mater. The coloring matter appeared to have been derived from the colored blood corpuscles.

The gray matter of the cerebellum, medulla oblongata and spinal cord was entirely changed in its appearance, as in the case of insanity and tetanus. It presented a deep reddish, grayish and pink color, from the great enlargement and increase of the capillaries. The ganglionic cells had disappeared to a great extent, and their place was occupied by enlarged capillaries. Masses of hæmatin were also discovered amongst the nervous structures. Many of the nerve cells were filled with granular matter.

Comparative examinations were made with a healthy brain and medulla and spinal cord, and it was thus clearly shown that the nerve cells in the diseased brain and spinal cord were diminished and altered in the most marked manner, and appeared to be not one-fourth as numerous as in healthy nerve-structures.

We have here, as in the preceding cases, grounds for referring the aberrated nervous phenomena and paralysis during life, to palpable structural alterations of the ganglionic cells and capillaries.

In the following case, which occurred in my hospital practice, *Elephantiasis* of the lower extremities was accompanied with *paralysis agitans* and *atrophy* of the *spinal cord*: Stephano Boralick, age 52, native of Austria; entered Charity Hospital Oct. 19th, 1871, and died November 7th, 1872; remained in the Hospital twelve months and nineteen days. When the patient entered Ward 13, on the 19th of October, 1871, both legs, from the knees downwards, and the feet were much enlarged, and the surface of the extremities presented a nodulated and livid appearance. The enlargement of the extremities was due to the hypertrophy of the integuments, and I regarded the disease as similar to the Elephantiasis of the Egyptians. There was also loss of power in the spinal system of nerves. The hands and legs trembled incessantly when the patient made any motion. Stephano walked with difficulty, with a tremulous, uncertain gait. Alteratives (Iodine, Iodide of Potassium, Iodide of Iron, Arsenious Acid, Red Iodide of Mercury), and nervine Tonics (Strychnia, Quinia, etc.), and generous diet, produced temporary improvement, with slight increase in strength and flesh. The improvement, however, was only temporary, and endured for about six months. Then the patient began to decline gradually in strength, and at the end of eight months from his entrance into the Hospital, was permanently confined to his bed, from a total inability to stand upon his feet, or to coördinate the movements of the lower extremities. With the gradual loss of nervous power, and especially during the period in which the patient was confined to bed, the legs gradually decreased in size, and at the time of death the integuments presented a shrivelled appearance. The intellect appeared to be unaffected throughout the disease. After death, I exposed the spinal cord, and found it to be hardened and atrophied. The gray cells of the cord were diminished in number; and the white commissural matter was much harder than normal.

Case 58: Paralysis; progressive failure of muscular and nervous power; Death; Structural Lesion in Spinal Cord.

Negro man ——; aged 45 years; native of Louisiana; has lived and worked all his life on a sugar plantation, where he was often necessitated to work in water, and was subjected to the action of malaria.

Admitted to the Charity Hospital, January 8th, 1869; patient states that he has suffered during his life with frequent attacks of malarial fever, of the intermittent form; last July, whilst working every day in deep water, often without eating food until night, began to suffer with pains in different parts of his body, but more especially in the lower extremities; these pains grew worse from day to day, and about Christmas he found that he had lost the power of using his legs, not being able to walk without great difficulty.

During the summer and fall months, the patient had suffered much with cephalalgia and intermittent fever. Has never had syphilis. At the time of his admission suffered from constipation of the bowels; but the bowels were regulated under the use of Strychnia, Iron and Aloes.

Magneto-electric shocks, seemed rather to increase, than to benefit the loss of nervous power, and this agent was consequently abandoned. The patient had been kept upon small doses of Strychnia and Iron, with benefit. At the present time, the patient has but little use of the lower extremities, cannot raise himself from a sitting to a standing posture, except by climbing, as it were, up the bedpost, raising nearly the whole weight by the muscles of the arms and shoulders; after getting to an erect position, cannot take a step, without holding to a support; by the aid of two walking canes he can walk slowly across the floor, by moving his feet about two inches at a time, dragging his toes along the floor. Paralysis of the flexors of his legs in his efforts to walk, the feet appear to be raised by lifting the entire leg, by means of the muscles attached to the hips; subsultus tendinum in left leg. General sensation and reflex action, unimpaired; no failure of special senses; intellect as bright as usual in his race; digestion normal; thoracic and abdominal viscera in healthy condition.

In this case, the prolonged action of malaria, repeated attacks of intermittent fever, together with the depressing effects of working in water, knee deep, were attended with rheumatic pains, gradual loss of power in lower extremities, constipation, general asthenia, subsultus tendinum in his legs, and inability to rise from the sitting posture. It is possible that the affection of the spinal cord, may have been due to rheumatic inflammation of its membranes, as well as to the slow and prolonged action of malaria and other depressing agencies.

This patient died on the 6th of May, 1869. The powers gradually failed, and he died apparently from exhaustion of the circulatory and respiratory systems.

The brain and spinal cord, were taken out and carefully examined. Nothing special was noticed in the cerebrum and cerebellum, but the pia-mater and arachnoid membrane of the spinal cord, in several portions, presented a light brownish discolored appearance, as if discolored by a weak solution of the Nitrate of Silver.

This discoloration was found to be due to the deposition of minute crystalline dark masses of hæmatin in the cellular tissue.

The blood-vessels of the pia-mater of the spinal cord, appeared to be larger and more numerous than normal.

When a section of the cord was made, the great and characteristic alteration was observed in the ganglionic matter. The gray matter, presented a pinkish appearance; under the microscope the gray cells were found not only to be greatly diminished, but many of them were entirely altered, being filled with colored granular masses, and some also contained oil globules. Masses of hæmatin, were also seen in the intermediate spaces. The blood-vessels (capillaries), were greatly increased in size, with thickened walls, to which colorless exudations and spindle-shaped corpuscles were attached. The change in the capillaries was marked.

Case 59:—Negro man, aged 63, a cooper by trade, who had been quartered in a low, damp locality, with poor diet, consisting chiefly of salt pork and bread; habits intemperate. Has suffered for some months with pain in back, located chiefly in lumbar regions. About one month ago was attacked with intermittent fever of tertian type; suffered with three paroxysms, and up to the present time has been subjected to "light fevers at night." Suffered with constipation of the bowels for two weeks from the first chill. Says that pains in the arms and knees came on about the time of the first chill, and these have gradually increased in intensity. During the last four weeks the patient has gradually lost power in the upper extremities.

February 6th. The patient complains of sensations of cold in arms, and keeps them wrapped up in flannel; pains in lower extremities and back, in lumbar region; some subsultus tendinum in arms; paralysis of both arms and of extensors of fore-arms; want of full control of lower extremities; when walking, inclines his body forwards, and walks with an unsteady, swinging gait; complains of stiffness in the back, and of inability of standing erect; unable to arise from the sitting posture; unable to retain his water and fæces; involuntary micturition and defecation occurring, if he does not obey the calls of nature at once; arcus senilis present; some enlargement of the parotid gland on the right side; no loss of sensation; tongue moist; back of tongue coated with yellow fur, tip and edges clean and red; appetite good, bowels regular; slight cough, with bronchial expectoration; sounds of heart feeble, and not well defined; pulse soft, weak, irregular and intermittent, eighty-four to the minute.

The patient was put on Cod-Liver Oil, Strychnine and Iron, with nutritious diet, and the arms rubbed with Volatile Liniment combined with minute portions of Strychnine.

Patient continued to improve slowly, with an increase of power in the arms, and was able to get the left hand to his mouth in eating until the 15th of February, when he had a chill followed by fever. On the night of the 15th, the patient took ten grains of Blue Mass, which was followed by fifteen grains of Sulphate of Quinia, on the 16th. The bowels were moved frequently, and the discharge passed involuntarily; and the patient appeared much exhausted; and in sleeping the left cheek appeared flabby, and there was a puffing of the left buccinator during respiration.

Stimulants and nutritious diet appeared to exert no beneficial effects, and the patient gradully sank and died on the 18th. Consciousness and intelligence were retained to lastthe moment.

Autopsy three hours after death.—The post-mortem was performed three hours after death, and the brain, and spinal cord and viscera, exhibited to the Medical Class. Structures anæmic; heart pale and apparently undergoing fatty degeneration. The degeneration appeared to be greatest in the muscular structures of the auricles. Under the microscope, the at globules were more abundant in many portions of the heart than in health, but the muscular fibres were generally healthy in appearance, and presented well marked striæ; the oil globules were most abundant between the muscular fasciculi.

Nothing abnormal was discovered in the valves of the heart and pulmonic artery and aorta, the feeble, irregular action of the heart, with its abnormal sounds during life, were clearly referable to the anæmic condition of the blood, and to incipient fatty degeneration.

All the cavities of the heart contained clots firmly attached to the muscular columns and valvular cords. The right auricle was especially distended with an enormous clot, which, when removed, presented a complete cast of its interior. These clots were composed of two portions, a well defined, fibrous, light-colored, dense, elastic portion, and coagulated blood. From their compound and laminated structure, they had evidently been partly formed during the last hours of existence. The spleen was enlarged to twice the size and slightly softened. The liver and alimentary canal appeared healthy; so also the kidneys.

The affected muscles were exhibited, and presented a red, healthy appearance, quite different from that of muscles undergoing fatty degeneration, or progressive atrophy. After careful microscopical examination, it was impossible to discover any marks of disease in the muscles, even in those which had been most completely paralyzed.

The entire brain and spinal cord were exposed. To the naked eye no structural alterations could be perceived upon the exterior. There were no marks of inflammation of the membranes, and no deposit, or tumor, or abscess, which would account for the paralysis of the arms, and of the extensors of the fore-arms, and inability to rise from the sitting posture, and loss of power in the lower extremities, and want of control over the bladder and sphincter of the anus and rectum during life.

Great difficulty is experienced in such examinations, as the modes of hardening the nervous structures, and the act of making sections of the brain and spinal cord, may, if not carefully performed, lead to deceptive appearances and erroneous conclusions. In many cases, pathologists have failed to detect well marked lesions of the cerebro-spinal system, in the paralysis of lead-poisoning, of mercurial cachexia, and in the tetanus produced by wounds and strychnia.

The cerebral function in this case was unimpaired, and sensation and reflex action were intact; it appeared reasonable to refer the loss of power, chiefly to some lesion of the motor ganglia of the spinal cord. As the upper extremities were more affected than the lower, whilst the impulses of the will were unimpaired, and sensitive impressions were communicated with the usual intensity, it seemed most reasonable to refer the lesion to some alteration or loss of power in the ganglionic cells of the anterior horns of the spinal cord, which may be considered as the origin of the anterior roots of the motor nerves.

Microscopical investigation was directed to the determination of the condition of the ganglionic cells of the anterior horns of the spinal cord; it appeared that they were diminished in number. The gray matter of the spinal cord also presented a redder color than in health, and the capillaries supplying the ganglionic cells were larger, and their walls thicker than in healthy nervous structures.

GENERAL CONCLUSIONS AS TO THE NATURE AND PATHOLOGICAL LESIONS OF TRAUMATIC TETANUS AND OTHER DISEASES OF THE NERVOUS SYSTEM.

From the preceding investigations and researches into the pathological alterations characteristic of Traumatic Tetanus, and other diseases of the nervous system, the following conclusions may be drawn:

1st. The nerves leading from the wound in cases of Traumatic Tetanus, exhibit, in most cases, evidences of congestion, irritation, and in some cases, even inflammation and alteration of texture. Besides the inflammation which is seen in the nerve at the spot which has been injured, a rosy reddening is produced at irregular intervals in its course by the injection of its neurilemma.

2d. In Traumatic Tetanus, the blood-vessels of the cerebellum, medulla oblongata power, and this agent was consequently abandoned. The patient had been kept upon doses of Strychnia and Iron, with benefit. At the present time, the patient has but little of the lower extremities, cannot raise himself from a sitting to a standing posture, except climbing, as it were, up the bedpost, raising nearly the whole weight by the muscles of arms and shoulders; after getting to an erect position, cannot take a step, without hold to a support; by the aid of two walking canes he can walk slowly across the floor, by ing his feet about two inches at a time, dragging his toes along the floor. Paralysis of flexors of his legs in his efforts to walk, the feet appear to be raised by lifting the entire by means of the muscles attached to the hips; subsultus tendinum in left leg. General sation and reflex action, unimpaired; no failure of special senses; intellect as bright as in his race; digestion normal; thoracic and abdominal viscera in healthy condition.

In this case, the prolonged action of malaria, repeated attacks of intermittent fever, toget with the depressing effects of working in water, knee deep, were attended with rheum pains, gradual loss of power in lower extremities, constipation, general asthenia, subsu tendinum in his legs, and inability to rise from the sitting posture. It is possible that affection of the spinal cord, may have been due to rheumatic inflammation of its membrane as well as to the slow and prolonged action of malaria and other depressing agencies.

This patient died on the 6th of May, 1869. The powers gradually failed, and he apparently from exhaustion of the circulatory and respiratory systems.

The brain and spinal cord, were taken out and carefully examined. Nothing special noticed in the cerebrum and cerebellum, but the pia-mater and arachnoid membrane of spinal cord, in several portions, presented a light brownish discolored appearance, as if colored by a weak solution of the Nitrate of Silver.

This discoloration was found to be due to the deposition of minute crystalline dark mas of hæmatin in the cellular tissue.

The blood-vessels of the pia-mater of the spinal cord, appeared to be larger and numerous than normal.

When a section of the cord was made, the great and characteristic alteration was obs in the ganglionic matter. The gray matter, presented a pinkish appearance; under microscope the gray cells were found not only to be greatly diminished, but many of were entirely altered, being filled with colored granular masses, and some also contain globules. Masses of hematin, were also seen in the intermediate spaces. The blood-ves (capillaries), were greatly increased in size, with thickened walls, to which colorless tions and spindle-shaped corpuscles were attached. The change in the capillaries was

CASE 10:—Negro man, aged 62, a cooper by trade, who had been quartered in a low, locality, with poor diet, consisting chiefly of salt pork and bread; habits intemperate. suffered for some months with pain in back, located chiefly in lumbar regions. About month ago was attacked with intermittent fever of tertian type; suffered with three par oxysms, and up to the present time has been subjected to "light fevers at night." Suf with constipation of the bowels for two weeks from the first chill. Says that pains in arms and knees came on about the time of the first chill, and these have gradually incre in intensity. During the last four weeks the patient has gradually lost power in the up extremities.

February 6th. The patient complains of sensations of cold in arms, and keeps wrapped up in flannel; pains in lower extremities and back, in lumbar region; some sultus tendinum in arms; paralysis of both arms and of extensors of fore-arms; want of control of lower extremities; when walking, inclines his body forwards, and walks with unsteady, swinging gait; complains of stiffness in the back, and of inability of stand erect; unable to arise from the sitting posture; unable to retain his water and fæces; untary micturition and defecation occurring, if he does not obey the calls of nature at arcus senilis present; some enlargement of the parotid gland on the right side; no los sensation; tongue moist; back of tongue coated with yellow fur, tip and edges clean and appetite good, bowels regular; slight cough, with bronchial expectoration; sounds of feeble, and not well defined; pulse soft, weak, irregular and intermittent, eighty-four to minute.

The patient was put on Cod-Liver Oil, Strychnine and Iron, with nutritious diet, and arms rubbed with Volatile Liniment combined with minute portions of Strychnine.

Patient continued to improve slowly, with an increase of power in the arms, and was to get the left hand to his mouth in eating until the 13th of February, when he had a followed by fever. On the night of the 13th, the patient took ten grains of Blue Mass, was followed by fifteen grains of Sulphate of Quinia, on the 14th. The bowels were frequently, and the discharge passed involuntarily; and the patient appeared much exha ed; and in sleeping the left cheek appeared flabby, and there was a puffing of the left cinator during respiration.

Stimulants and nutritious diet appeared to exert no beneficial effects, and the patient gr and died on the 18th. Consciousness and intelligence were retained to lastthe

y three hours after death.—The post-mortem was performed three hours after death,
brain, and spinal cord and viscera, exhibited to the Medical Class. Structures
heart pale and apparently undergoing fatty degeneration. The degeneration ap-
be greatest in the muscular structures of the auricles. Under the microscope, the
les were more abundant in many portions of the heart than in health, but the mus-
es were generally healthy in appearance, and presented well marked striæ; the oil
were most abundant between the muscular fasciculi.
g abnormal was discovered in the valves of the heart and pulmonic artery and aorta,
, irregular action of the heart, with its abnormal sounds during life, were clearly
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In Traumatic Tetanus, the blood-vessels of the cerebellum, medulla oblongata

and spinal cord, and especially of the gray matter of the medulla oblongata and spinal cord, are dilated and congested.

It is possible, by cold and irritants applied directly to the cerebellum, medulla oblongata and superior portions of the spinal cord, to produce dilatation and congestion of the blood-vessels, and the congestion thus produced, is attended with exalted and aberrated action of the cerebellum and spinal axis, and spasms of the voluntary muscles, resembling the abnormal nervous action characteristic of Traumatic Tetanus. We are therefore compelled, in view of these facts, to regard the dilatation and congestion of the small arteries of the cerebellum, medulla oblongata and spinal cord in Tetanus, as of great importance, and as indicating, not only an increased functional activity in the central ganglionic cells, but also paralysis or arrest of the action of that portion of the sympathetic nervous system which presides over the circulation of the cerebellum, medulla oblongata and spinal cord.

3d. When the dilatation and congestion of the blood-vessels of the cerebellum and spinal axis, characteristic of Traumatic Tetanus, are examined in the light of careful physiological experiments, they appear to be dependent upon some arrest or alteration of the influence supplied to the unstriped muscular fibres of the minute arteries, leading to dilatation of their diametres, and enfeeblement, if not complete arrest of the normal peristaltic actions. The gray cells of the cerebellum, medulla oblongata and spinal cord are thus supplied in Traumatic Tetanus, with an increased amount of blood, even when there is no increase in the force and frequency of the heart's action. The sympathetic nervous system, which regulates the circulation of the blood in the minute arteries, appears to be involved in Traumatic Tetanus.

4th. It is difficult to determine the exact relationship of the disturbances in the two systems of nerves, viz: Whether the irritation is reflected from the wounded surface, first to the ganglionic cells of the cerebro-spinal system, and secondarily to those of the sympathetic in the spinal axis, as well as in the ganglia of organic life, in virtue of the intimate relationship of the two systems, and in virtue of the dependence of the lesser upon the greater, in highly organized animals, for a continuous supply or renewal of nervous force? or whether the influence affects primarily the ganglionic cells of the sympathetic system? It would appear that after the establishment of the state of increased functional activity in the ganglionic cells of the spinal axis, there is at least an enfeeblement of the sympathetic system, and especially of that portion which presides over the circulation of the central ganglionic masses; and the question arises, whether this impairment of its normal functions be due to a diversion of the nerve force ordinarily received from the cerebro-spinal system?

If the vaso-motor nerves be connected with the motor and sensitive ganglionic cells, as well as with sympathetic ganglionic cells in the spinal cord; and if the arteries are normally kept in a due state of contraction, and the capillaries duly retentive of their contents, by the influence propagated continuously from the sympathetic ganglionic cells, then it is evident that if the motor and sensitive cells be over-excited, the nervous influence may be withdrawn from the sympathetic cells, and through them from the vaso-motor system, and engorgement, effusion and alteration of nervous structure result.

When, therefore, the condition of superfunctional activity is established in the motor and sensitive cells of the spinal axis, by the transmission of the irritation along the nerves connected with the injured parts, this very exaltation of nervous action tends to propagate and perpetuate itself by withdawing the nervous influence from the vessels upon which the ganglionic cells depend for the proper supply of nutritive materials. We are thus enabled to understand why a certain length of time elapses between the reception of the injury, and the manifestation of the tetanic spasms.

By these inquiries, and by this chain of reasoning, we are led to the conclusion that the irritation is transmitted along the injured nerve to the motor and sensitive ganglionic cells of the spinal cord, and extends gradually from the point of entrance of the irritated nerve, until the medulla oblongata and ganglionic masses at the base of the

e involved, and the gradual exaltation of the nervous force in the motor and
cells is attended with a corresponding diminution in the sympathetic cells, the
sels become dilated and engorged, and with this change we have the full mani-
of the phenomena of Traumatic Tetanus; the disease, therefore, advances
t first, and when once established, tends, as it were, to propagate itself.

The continuance of the state of congestion leads to structural alterations of
al cord, characterized by increased specific gravity, commencing most generally
egion of the cord in immediate communication with the wounded part; exuda-
organizable material from the congested blood-vessels; proliferation of the con-
tissue of the medullary substance of the medulla oblongata, of the inferior
les of the cerebellum, of the crua cerebri and of the spinal cord, producing a vis-
ass abounding in nuclei and nerves progressing to the formation of fibres; exu-
of structureless, transparent material in the immediate vicinity of the vessels,
y intruding itself into the tissue, and displacing the neighboring parts; escape of
corpuscles from the blood-vessels replete to distension with their natural con-

pathological lesions of the spinal cord in Tetanus, are frequently of surprising
, consisting of disintegration and softening of a portion of the gray substance,
appears in certain parts to be in a state of solution.

The structural alterations of the cord in Traumatic Tetanus are not primary,
ondary; they are the *results* of, rather than the *cause* of, the congestion of the
vessels, and cannot therefore be looked upon as the cause of the aberrated, nervous
. This is clearly shown by the pathological investigations of Insanity and Para-
for in these diseases, we have similar lesions, without tetanic spasms. And in
y, in which similar lesions to those of Traumatic Tetanus are found in the
a oblongata, the spasms are separated by long intervals, and a careful analysis of
enomena of this disease, showed that whilst they were aggravated and perhaps,
ed incurable by the pathological changes of certain portions of the spinal axis, at
ne time, these changes followed rather than preceded the establishment of the
d action. The lesion of the spinal cord in Tetanus, consisting of exudations and
grations, are similar in character to those observed in Insanity, Paralysis and
sy; and clearly depend, as in these diseases, upon a morbid state of the blood-
of the cord. Whilst therefore these lesions may intensify the symptoms, and
the disease incurable, they are by no means necessary to the manifestation of the
; and it is highly probable that in these cases of Tetanus which recover, they
her not present, or are present only in a slight degree.

The following appears to be the order of the lesions of the nervous system, as
d from the preceding investigation:

Peripheral irritation of the injured nerves

Extension of the peripheral irritation to the ganglionic cells of the segment of
inal cord, connected with the injured nerve.

Extension of the irritation to other segments of the spinal cord, and especially
medulla oblongata.

Exalted action of the ganglionic cells of the spinal axis, arising either from an
ion of a similar state along the injured nerves from the periphery, or from reflex
on its blood-vessels, excited by the injured nerves.

Congestion of blood-vessels, hyperæmia, and morbid state of blood-vessels of
axis, and especially of gray matter of medulla oblongata and superior portion of
cord.

Exalted reflex actions, morbid excitable conditions of gray substance of cord
rebellum, and tetanic spasms, trismus, emprosthotonos, etc.

Exudations and transmigrations of colorless corpuscles from the distended
, and structural alterations of nerve cells and fibres.

The character and extent of the pathological lesions discovered in the spinal
ter death from Traumatic Tetanus, will depend in large measure upon the duration

of the disease. Thus, if the patient dies, in the earlier stages, from sudden spasm of the respiratory muscles, or of the epiglottis, little else will be discovered besides dilatation and congestion of the blood-vessels of the injured nerve, and of the medulla oblongata and spinal cord, and especially of the gray matter of the spinal axis.

The diverse views held by writers upon the pathology of Traumatic Tetanus (a large number including all those who have made careful sections and microscopical examinations of the cord, holding to the existence of distinct recognizable lesions; others who have only superficially examined the brain and spinal axis, giving forth confused, contradictory, and unreliable assertions as to the purely functional nature of the disease,) are clearly referable to the stage of the disease, at which death took place, and to the mode in which the post-mortem examinations were conducted.

9th. Pathological alterations have been detected in the sympathetic nervous system, in some cases of Traumatic Tetanus; but farther and more careful observations are needed to determine the character and uniformity of these changes; for the number of cases in which the organic system of nerves has been examined, is comparatively small.

10th. *Certain external conditions, as sudden changes of temperature, extremes of heat and cold, and variations in the moisture of the atmosphere, appear evidently to induce such changes in the wound, and in the nervous system, and in the entire organism, as favor the development and progress of the disease.*

RESEARCHES PROSECUTED WITH THE DESIGN OF DETERMINING THE RELATIONS OF CERTAIN EXTERNAL CONDITIONS, AS CLIMATE, SUDDEN CHANGES OF TEMPERATURE, EXTREMES OF HEAT AND COLD, AND VARIATIONS OF MOISTURE TO THE DEVELOPMENT OF TRAUMATIC TETANUS.

Whilst Tetanus is met with in every part of the globe, it is to a certain extent, influenced in its origin and progress by climatic causes; thus it is said to occur oftener in sultry than in temperate climates, and prevails more at the hot seasons, or during sudden changes from hot to cold, especially in a moist state of the atmosphere, so common in the tropics; sudden vicissitudes of temperature, therefore, have always been looked upon, as most powerful exciting causes of the disease. Baron Larrey has recorded numerous observations, illustrating the effects of cold and damp, and sudden changes of temperature, in the production of Tetanus after gun-shot wound. Among the wounded in the battle of the Pyramids, five were attacked with tetanus occasioned no doubt, by the humidity and coldness of the night. After the combat of El-Arich, the wounded were put into tents, on a damp soil, exposed to continual rains. Eight were seized with tetanus, which presented itself under all its symptoms, and terminated in death, on the fifth and seventh days from its commencement.

Those who were wounded in the battle of Aboukir, 1798, were carried to the hospitals of Alexandria, as soon as they had received the first dressing; ten of them being exposed to the air and coolness of the nights, were seized with tetanus. Its rapid progress and the situation of the wounds, in the head, trunk, or superior part of the thigh rendered all assistance of no avail.

Baron Larrey observes that:

> "In cases in which cold contributes to the development of tetanus, the irritation transmitted from the wound to the nervous system, is augmented by the suppression of cutaneous perspiration, which extends its effects to the organs and principally to the parts already diseased; but the irritation is principally concentrated in the nerves of the neck and throat, at the commencement of the disease, or its termination. Their direct connection with the medulla oblongata, and spinal marrow, their numerous interlacings, and frequent anastomoses render them liable in the slightest impressions, to violent irritability which causes the contraction of the muscles of these regions, in such manner, as quickly to interrupt deglutition and respiration."

Baron Larrey remarked, both in Egypt and in Germany, that Tetanus was not often caused by wounds, unless the temperature of the atmosphere pass suddenly from one extreme to another. The wounded who were exposed more especially in the spring, to the cold moist air of the nights, when the northwest winds prevailed were more obnoxious to tetanus; on the contrary, the disease seldom appeared when the temperature of the air was nearly uniform. Hence he concluded that this change of temperature is a predisposing cause of tetanus, and that surgeons should guard against it in their treatment of the wounded.

Dr. R. Huck, physician to the English Army, in the last century, states that of thirteen wounded men, whom he had seen afflicted with *locked-jaw*, nine received their wounds at the attack of the French lines at Ticonderoga, in the year 1758, and remained exposed to the cold air, the night after the action, in open boats upon lake George.

M. Francois, of Auxern, observes that on board the Amazon Frigate, before Charlestown, during the American War, after some stormy and very wet weather, which had succeeded a continuance of dry, most of those wounded by fire-arms were attacked by Tetanus on the 14th day.

Dazille, Campet, Rush, Chalmers, Curling and others, have given illustrations of the predisposing influence of climate and atmospheric changes in exciting this disease.

Bryan Edwards, in his History of the British Colonies in the West Indies, mentions a *species of tetanus or locked jaw*, which causes great mortality among the negroes in the West Indies, "affecting infants between the fifth and fourteenth days after their birth, and of which it is supposed that *one-fourth of all the negro children perish.*" Vol. ii p. 352.

Sir Gilbert Blane, in his Observations on the Diseases of Seamen, thus attempts to explain why Tetanus

> "Is more frequent in hot than in cold climates. External heat, even when it exceeds that of the living body, has no effect in raising its temperature. So that we are to seek for the effects of it in some of those affections peculiar to animal life. And as the outward temperature of the air does not affect the general mass of the body, all the effects produced by it must depend on impressions made on the surface of the body and lungs; and the skin which may be considered as a large expanded tissue of nervous fibres endowed with universal sympathy and great sensibility, affects every organ and every function of the body, according to the state of the air, in contact with it, whether cold or hot, moist or dry, pure or vitiated. The same may be said of the trachea and bronchia. This sympathetic sensibility of the skin is chiefly affected by the state of the perspiring pores on the surface; for it is only when these are open, that the impression of the air on the skin produces catarrhs, rheumatisms, and internal inflammations in cold climates; and the external temperature in hot climates, being such as to keep the pores almost always open, this seems to be a principal reason of that universal irritability prevailing there, and of the general sympathy that prevails between every part, particularly as connected with the organs of perspiration. This readiness of one part to be affected by another, in hot climates, is well illustrated by the sudden translation of certain diseases. I have seen for instance, a catarrh cease, and be converted as it were into a diarrhœa, and this as quickly disappearing a pain in the foot would rise like an attack of gout. All this would happen in the space of a few hours. (Observations on the Diseases of Seamen, 3d Ed. 1799, pp. 564–566).

The same circumstances appear to induce the disease in animals.

Hurtrel d'Arboval relates, that twenty-four horses were castrated on the same day, at Bee, in the department of l'Eure. They were afterwards led four times in the day, through a pond of water supplied from a very cold spring. Sixteen of them died, between the tenth and fifteenth day after the operation. At Rennes, a horse after castration was exercised, until he was covered with perspiration, and then suddenly plunged into the river. This was repeated three times, and the animal died tetanic. (Dictionnaire de Médecine, et de Chirurgie Vétérinaire, tom. iv, p. 263).

After the battle of Bautzen, the exposure to a very cold night, produced over a hundred cases, and after the battle of Dresden, when the wounded were placed in like circumstances, they lost a very large number from tetanus.

Baudens, gives a very interesting instance from his African experience, showing the influence of cold and moisture, in producing this disease: forty slightly wounded men were placed, in the month of December, and during the prevalence of a northeast wind, in a gallery on the ground floor, which was open to the north; fifteen different cases of tetanus appeared in a short time—among this number, twelve died. The remainder were removed to a more sheltered place, and these were no more attacked.

Opposite extremes of temperature, appear to cause similar effects; thus in the Indies heat is looked upon as a predisposing cause. While in the arctic regions, extreme cold excites under certain circumstances idiopathic tetanus. According to Sir Gilbert Blane out of 810 wounded men, who came under his observation in the West Indies, in 17 thirty were seized with tetanus, and seventeen died.

Dr. Kane, during his explorations in the Arctic-regions, records the interesting fact that intense cold produced "an anomalous spasmodic affection allied to Tetanus," which affected most of his party, and destroyed two men, and killed all his dogs.

In his "Report upon the Cases of Tetanus in the Jamjetzee Jejeebhoy Hospital, Bombay, from January, 1845, to December, 1851," Mr. J. Peet, Assistant Surgeon to the Hospital, states that during these seven years, 195 cases of Tetanus were admitted into the hospital, exclusive of some 78 or 80 persons who were attacked subsequently to their admission, making the whole number treated during this period, about 2 This appears to be the largest number of cases of Tetanus treated in any single hospital in the world. Mr. Peet concludes that the idiopathic form of Tetanus is much more frequent in Bombay than in other parts of the world, and that, contrary to the experience of the disease in other places, it is more severe and fatal than the traumatic species; and that it is often traceable to direct exposures at those seasons, during which there are the greatest alterations of temperature.—Trans. Med. and Phys. Soc. of Bombay, No. 1, N. S., Bombay, 1853.

Mr. Waring, in his "Notes on the Diseaseas of India," has recorded valuable observations upon the relative frequency of the occurrence of Tetanus, of which the following is an analysis:

Frequent as this disease (Tetanus) is represented to be in Demerara, Trinidad, St. Domingo, and in some other localities in the West Indies, no comparison can be instituted between its frequency in these places and in some of the towns of India, Bombay especially, as will be seen by a perusal of the following statement, showing the deaths from Tetanus in the town of Bombay, for a period of three years, 1851, 1852 and 1853:

YEAR.	TOTAL DEATHS.	DEATHS FROM TETANUS.	PROPORTION.
1851	14,724	332	One death from tetanus to 44 from all causes.
1852	13,763	341	" " 40 " "
1853	14,164	239	" " 39 " "
	42,651	912	One death from tetanus to 46 from all causes.

Large as this number is, both absolutely and comparatively, it is still below the mark, as under the heading of total deaths are included still births, whilst under that of Tetanus is excluded that peripheral form of the disease, which is both frequent and fatal in Bombay. There is no means of comparing the proportion of tetanic deaths in Calcutta and Madras with those of Bombay, but if an opinion may be formed from hospital returns, it appears that the disease is not of so frequent occurrence in Calcutta as in Bombay. Thus, in the Calcutta General Hospital, (Dr. Jackson; India Annals of Medical Science, No. 1, 1853, p. 58), during five years, (1847–51), only 56 were admissions with Tetanus, whilst at the Jamjetzee Jejeebhoy Hospital, (Mr. Peet, Bombay Med. Trans., No. 1, N. S., 1853, p. 1), in Bombay, during a period of seven years, (1845–51), the admissions under this heading, amounted to 195.

Compared with more temperate climates, the ratio of deaths from Tetanus appear still more striking; thus we find the following proportion to exist:

PLACE.	PERIOD.	TOTAL DEATHS.	DEATHS FROM TETANUS.	PROPOR'N
ondon	1850–3–4	224,515	73	1 in. 3075
reland	1831–1851	1,187,374	238	1 in. 4987
New York	1819–1834	83,783	112	1 in. 748
Bombay	1851–1853	42,651	912	1 in. 46

The proportion existing in Bombay, taken in this light, cannot but be regarded as very formidable.

Influence of Seasons.—In seeking to ascertain the cause of so prevalent a disease, one of the first questions which presents itself, is, what were the atmospheric and meteorological conditions of the locality during the period of its prevalence? Fortunately, good data exist, from which a judgment may be formed as to the relations of Tetanus to the seasons in Bombay. The following table presents the monthly deaths from this disease in Bombay, during a period of three years, 1851–1853.

MONTHS.	1851	1852	1853	Total.	Total Deaths in Quarters, and per cent.
February	28	32	14	74	242, or 26,5 per cent.
March	26	35	24	85	
April	26	36	21	83	
May	28	22	25	75	220, or 24.1 per cent.
June	21	34	21	76	
July	27	21	21	69	
August	29	24	17	70	226, or 24.9 per cent.
September	31	28	18	77	
October	30	24	25	79	
November	29	35	22	86	224, or 24.8 per cent.
December	29	29	14	82	
January	18	21	17	50	
Total	332	341	239	912	

This table shows that in Bombay, seasons *per se*, exercise no influence on the mortality in Tetanus, each quarter presenting very nearly the same proportions of death. A slight increase is observable in the month preceding the rains, (May), but nothing sufficiently marked to allow us to place any stress upon it. For some other cause, therefore, must we look; it cannot well be lowness of site, as both Madras and Calcutta are, equally with Bombay, very slightly elevated above sea-level. So, likewise, it cannot be poverty, wretchedness or want of drainage, otherwise Calcutta and Madras would produce quite as many cases as Bombay. From the preceding investigation, Mr. Waring concludes that its cause yet remains to be discovered.—Half-Yearly Abstract of the Medical Sciences, edited by W. H. Ranking and C. B. Radcliff, July, 1856, pp. 55–56.

From an important "Report of Seventy-two Cases of Tetanus, occurring in Guy's Hospital," from 1825 to 1857, by Alfred Poland, we extract the following statistics, illustrating the relations of Tetanus to climatic causes:

In 32 full years, there occurred 72 cases of Tetanus in Guy's Hospital, in 113,020 total admissions, making an average of 0.063 per cent.; and there were 62 deaths from Tetanus, in 11,052 total deaths, or 0.56 per cent. Of these, all but three had a co-existing or previous lesion of the surface; they were called Traumatic, and hence might be ranked and included under the surgical class of cases. Thus, there will be 96 cases of Tetanus, with lesion of surface, to 64,368 cases admitted with external lesion and surgical disease, being 0.107 per cent.; and 61 deaths from Tetanus, to 4,218 cases of deaths from external and surgical disease, being 1.444 per cent.

In the Bombay Hospital, from 1848 to 1853, 0.8 per cent. of the total admissions were of Tetanus, and 3.9 per cent of the total deaths. Dr. Leith, Registrar of Deaths at Bombay, returns 1,716 deaths from Tetanus during the same six years, and states the per centage to be 2.5 on total deaths from all causes. In London, in six years, in 345,132 total deaths, 110 of Tetanus, or 0.031 per cent. In England, in the same space of time, the total deaths are 2,431,602, and 759 are of Tetanus, being 0.031 per cent.

A reviewer, in the October number of the American Journal of the Medical Sciences, 1858, presents, for the purpose of comparison, the following additional figures:

In 1853, the number of deaths from Tetanus in New York City, was 49, of which 35 were males and 14 females; the total deaths during the same year being, 28,568, we have one death from Tetanus in 583, or 0.17 per cent. In 1857, in Philadelphia, there were 13 deaths, in a total of 10.895, or one death in 836, which gives 0.12 per cent. From the tables of Dr. Emmerson (published in the American Journal of Medical Sciences, in the years 1827, 1831 and 1848), we have, that from the 1st of January, 1807, to the 1st of January, 1827, in a total of 53,004 deaths, in Philadelphia, 125 were from Tetanus, giving 0.236 per cent.; from 1st of January, 1827, to the 1st of January, 1830, there were 29 cases, in 16,579 deaths, giving 0.175 per cent.; from 1830 to 1840, there were 51 cases, in 49,686, giving 0.103 per cent. From these data, the disease would appear to be coming less common in this city. In Massachusetts, in five years, the total number of deaths from all causes, was 104,873; of these, 55 were from Tetanus, or, 1 in 1,907, which gives 0.05 per cent. These data are sufficient to show that Tetanus is much more common in this country, even in the more northern portions than in England. In Charleston, S. C., in 1856, in 1,428 total deaths, 57 were from Trismus Nascentium, and 6 from Tetanus, giving for Tetanus a percentage of 0.42, and for both diseases 4.42. In the Southern States, Tetanus seems to be much more frequent among the blacks than the whites; in Charleston, for example, from April, 1857, to April, 1858, there were 8 deaths from Trismus, and 2 from Tetanus, among the whites, and 37 from Trismus, and 8 from Tetanus among the blacks, while in the total deaths, there were about one-third more of the latter than of the former. (Am. Jour. Med. Sci. Vol. xxxvi. N. S. 1858, p. 476.)

I have carefully examined and consolidated the mortuary statistics of several Southern Cities, and the following tables embody the results of my investigations, with reference to the relative mortality from Tetanus, and the relations of this disease to Climate.

om Tetanus each month, and total yearly deaths from all causes, in Savannah, Georgia, amongst the white inhabitants, during a period of fifty years, 1804–1853, *inclusive.*

R.	POPULATION, WHITES.	Jan.	Feb.	Mar.	Apr.	May	Ju'e	July	Aug	Sept	Oct.	Nov.	Dec.	Death from all Causes.
	2799	1												207
														238
														159
														230
	3010													219
														183
														163
														212
														226
										1				214
				1										300
														233
														272
		1								1				461
														211
												1		510
								2						817
														385
											1			291
					1									268
														136
														126
				1		1								235
					1									321
														146
														209
								1						159
							1							147
														216
														202
														197
														228
														249
		1												358
														331
										1	1		1	367
	5888													380
				1				1						305
														272
														256
		2	1						1					247
								1		1	1			229
			1		1			1	1			1		240
		1						1	1	3				210
	7250		1				3	1						298
						1					1	1	2	357
	8395	1												384
		1			1									414
														642
		1	1	1		1			1		1			470
50 y'rs, 53		9	4	4	4	3	4	8	4	7	5	3	3	14,332

avannah, Georgia, during a period of 50 years, 1804–1853; out of 14,332 occurring amongst the whites, from all causes, 58 are recorded as caused by , under the several heads of Tetanus, Locked-Jaw and Trismus Nascentium. uld give amongst the whites, one death from Tetanus, in 229.8 deaths from all causes. These statistics do not, however, represent the entire number of deat Tetanus, and especially from Trismus Nascentium, for a large number of deaths in infancy a short period after birth, are recorded simply under the head of *Spa Convulsions*, as will be seen from the following table:

Deaths from Spasms and Convulsions amongst the whites in Savannah, Georgia, during a p fifty years, 1804–1853.

	Jan....	Feb....	March.	April..	May ...	June...	July...	Aug....	Sept...	Oct.....	Nov ...	Dec.....	Total Deaths from Spasms.	REMARKS.
1804	1	...	...	...	...	...	2	2	1	2	1	2	11	
1805	...	...	...	1	1	1	...	2	2	—	—	...	7	
1806	...	1	...	2	...	...	...	1	1	2	2	1	10	
1807	2	1	...	...	...	1	2	2	1	2	1	1	13	
1808	1	...	...	...	...	...	1	1	...	2	—	—	5	
1809	1	1	..	...	...	...	...	...	...	—	—	—	2	
1810	...	...	...	...	...	...	...	1	...	—	—	—	1	
1811	...	2	1	...	...	...	...	...	...	—	1	—	4	One case, 3 days old.
1812	...	...	...	3	...	...	...	1	...	—	—	—	4	One case, 8 days old.
1813	1	3	...	...	1	...	...	1	...	1	1	—	8	Two cases, 10 days old.
1814	...	...	...	...	...	...	...	...	...	2	—	—	2	
1815	...	...	...	...	...	...	1	...	1	—	1	—	3	
1816	3	...	1	...	...	1	2	...	1	1	1	—	10	
1817	1	1	1	...	...	...	...	...	...	—	—	—	3	
1818	...	...	1	1	...	...	...	1	1	—	—	—	4	
1819	...	...	...	...	...	1	2	...	4	1	1	—	9	Two cases, 8 days old.
1820	1	...	...	2	...	1	...	...	...	3	—	1	8	One case, 7 days old.
1821	...	...	...	...	1	1	1	...	2	1	—	—	6	One case, 4 days old; one 7, and one
1822	...	1	2	...	1	...	...	...	3	4	2	1	14	One case, 13 days old.
1823	...	2	3	...	1	...	...	1	...	—	1	1	9	One case, 7 days old.
1824	...	1	...	...	...	...	...	...	4	2	—	—	7	Two cases, 9 days old.
1825	...	1	1	...	...	1	1	1	3	2	—	1	11	Two cases, 6 days old.
1826	...	1	...	1	...	1	3	2	1	5	1	3	18	
1827	...	1	1	...	1	...	...	...	4	2	1	—	10	One case, 3 days old; one 7, and one
1828	...	1	...	...	...	...	1	1	1	—	2	—	6	
1829	...	1	...	2	...	3	...	...	1	—	1	1	9	Three cases, 5 d'ys old; one 11, and one
1830	...	...	...	...	...	...	...	...	2	—	—	1	3	
1831	2	2	...	1	...	1	2	...	1	1	1	—	11	Three cases from 5 to 7 days old.
1832	1	1	1	...	...	1	...	1	...	2	—	—	7	Two cases from 1 to 10 days; one
1833	2	1	...	1	...	...	...	4	3	1	1	—	13	One case, 6 days old; one 7; one 7
1834	...	...	...	...	1	1	...	1	1	1	1	—	6	One case, 4 days old.
1835	3	1	1	...	...	...	1	...	1	1	—	—	8	Two cases, 7 and 8 days old; one 5
1836	...	...	1	...	2	1	...	...	1	4	—	—	8	One case, 12 days old.
1837	2	...	2	...	1	2	3	1	...	—	—	—	11	Two cases, 6 and 8 days old; one 16
1838	...	1	1	...	1	1	...	...	...	1	2	—	7	Two cases, 9 days old; one 2 weeks.
1839	...	1	...	1	1	1	...	...	...	1	—	—	5	One case, 12 days old; one 5 weeks.
1840	...	1	...	...	...	...	...	1	3	2	5	1	13	Two cases, 6 and 7 days old; two 6
1841	...	...	...	1	1	...	...	2	2	—	—	—	6	One case, 10 days old; one 4 months.
1842	2	1	...	1	1	1	...	1	...	...	...	...	7	One case, 1 day old; two 2 months.
1843	...	2	2	...	...	...	2	...	1	1	3	3	14	Nine cases from 2 to 12 days old; one
1844	1	...	...	...	2	2	1	...	2	1	2	3	15	Four cases from 1 to 10 days old;
1845	1	1	...	3	1	...	1	2	3	10	2	1	25	Ten cases from 1 to 10 d'ys old; five 4
1846	1	2	1	3	1	2	2	5	2	4	2	2	27	Nine cases from 1 to 15 ds. old; six 5
1847	3	2	3	1	1	2	1	5	4	2	—	2	26	Fourteen cases were 14 days and
1848	...	5	3	2	4	5	3	...	...	...	8	1	33	
1849	2	2	2	1	1	2	2	1	4	3	—	1	21	
1850	1	1	1	...	1	2	4	2	4	2	5	1	24	
1851	4	5	...	2	2	3	2	2	2	4	7	3	37	
1852	3	6	3	2	2	4	3	5	7	3	15	6	63	
1853	4	7	2	2	2	6	5	6	7	11	6	6	65	
	42	37	33	34	32	48	50	56	82	50	91	43	656	

Six hundred and fifty-six deaths were recorded as due to convulsions and sp ah, amongst the whites during a period of fifty years, (1804–1853,) out of a 14,332 deaths from all causes; or one death from spasms and convulsions in 20.8 from all causes. Nearly one-half of these deaths recorded as due to spasms and ions, viz: 314, occurred during the months of August, September, October and ber, in which period it is well known that malarious diseases and especially inter-, remittent and congestive or pernicious fevers, prevail with the greatest intensity city, which is surrounded with marshes and low lands lying along the sluggish ddy river. Whilst therefore a certain proportion of these deaths may have been shortly after birth by Trismus Nascentium, the greatest proportion must be l to the action of the malarial poison.

ould have been of great interest to have presented the statistics of the black ion of Savannah, but after a careful examination of the records, I found them imperfect, that no reliable data could be gathered for an accurate judgment and ison. It appeared to be generally admitted, however, that the negro children uch more liable to Infantile Tetanus; and also that injuries were more frequently d by Tetanus amongst the negroes.

mortuary records of Charleston, South Carolina, furnish valuable data for the ination of the relative prevalence of Tetanus and Trismus Nascentium, in the nd black races, as will be seen from the following tables, which I have consoli- rom the yearly mortuary reports.

rom Traumatic Tetanus in Charleston, South Carolina, amongst White, Black and Colored Inhabitants, during a period of fourteen years.

	WHITES.													BLACKS AND COLORED.																
r.	Jan....	Feb ...	Mar...	April..	May ..	June..	July...	Aug ...	Sept...	Oct ...	Nov ...	Dec ...	Total..	Jan ...	Feb ...	Mar...	April..	May ..	June..	July...	Aug ...	Sept...	Oct. ...	Nov ...	Dec ...	Total..	Total deaths from Tetanus Whites and Blacks.	Total deaths from all causes.	Proportion of deaths to population, 1 death in—Inhabitants.
....	...	...	...	1	...	...	...	...	...	1	...	...	2	...	...	...	2	...	...	...	...	...	...	...	...	2	4	607	1 in 47.71
....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1	...	1	1	...	1	...	...	2	1	8	8	548	.. 54.74
....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1	...	...	...	...	...	...	1	2	...	5	5	617	.. 43.11
....	...	...	...	...	...	...	...	...	...	1	...	...	1	1	...	...	...	2	...	...	...	...	1	1	...	5	6	798	.. 36.34
....	...	...	...	...	...	...	1	...	...	...	...	...	1	1	...	1	2	...	...	1	...	1	...	...	1	7	8	922	.. 44.46
....	...	...	...	...	...	...	...	...	...	1	...	1	2	1	1	...	...	...	...	1	...	...	1	2	1	7	9	1582	.. 27.81
....	...	...	1	1	...	1	...	...	1	1	...	...	5	...	...	1	2	...	...	3	1	...	1	...	...	8	13	1876	.. 23.4
....	...	...	1	1	...	1	...	...	...	...	...	...	3	1	...	2	...	..	...	1	...	1	2	...	1	8	11	1088	.. 45.94
....	...	...	1	...	...	...	...	...	2	...	...	...	3	2	...	...	...	...	1	1	2	...	1	1	...	8	11	1237	.. 42.37
....	...	...	...	...	1	1	...	...	...	...	...	1	3	2	...	...	1	1	2	...	...	...	1	1	1	9	12	1922	.. 26.14
....	1	...	...	...	1	...	1	1	...	...	...	...	4	...	1	2	1	...	...	...	...	1	...	...	...	5	9	1033	.. 48.40
....	...	...	...	...	...	1	1	...	...	...	1	...	3	...	1	...	1	1	...	1	...	1	1	1	1	8	11	1472	.. 37.38
....	2	...	...	...	...	...	...	...	...	...	...	...	2	...	1	1	...	...	...	1	1	...	...	1	3	8	10	1380	.. 36.09
....	...	...	...	...	...	1	...	...	2	2	2	...	10	...	...	...	1	...	1	1	...	...	...	1	1	5	15	2068	.. 9.70
....	3	...	3	3	2	5	3	1	5	6	3	2	39	8	6	9	10	5	5	10	5	4	9	12	10	93	132	17150	

from Trismus Nascentium in Charleston, South Carolina, amongst the White, Black and Colored Inhabitants during a period of fourteen years.

	WHITES,													BLACKS AND COLORED.																
.	Jan....	Feb ...	Mar ...	April..	May ..	June..	July...	Aug ...	Sept...	Oct	Nov ...	Dec ...	Total..	Jan....	Feb ...	Mar...	April..	May ..	June..	July...	Aug...	Sept ..	Oct	Nov...	Dec ...	Total..	Total deaths from Tris. Nas. Whit's and Blacks.	Total deaths from all causes.	Proportion of deaths f'm all causes to population.
....	...	...	...	...	...	...	...	...	1	1	1	...	3	4	4	3	3	3	...	2	2	2	3	6	...	32	35	607	1 in 47.71
....	...	...	...	...	...	...	...	...	...	1	...	...	1	1	2	2	3	4	3	2	1	5	3	1	1	28	29	548	.. 59.74
....	...	...	...	...	...	...	...	...	...	...	...	...	.....	...	2	3	...	...	1	...	1	1	5	4	3	20	20	617	.. 43.11
....	...	...	...	...	...	...	...	...	...	...	...	...	.....	6	1	1	2	...	3	1	4	4	2	...	...	24	24	798	.. 36.34
....	1	...	...	1	...	...	...	...	1	1	...	1	5	3	3	1	...	3	2	4	6	4	6	3	2	37	42	922	.. 44.46
....	1	...	2	1	...	...	1	2	1	2	4	...	41	3	3	2	6	7	1	5	5	4	4	3	4	47	61	1582	.. 27.81
....	...	1	...	...	...	1	1	1	1	2	...	...	7	3	4	3	5	1	3	2	4	4	6	8	3	47	54	1876	.. 23.4
....	...	1	...	2	...	...	...	1	2	1	1	...	8	3	4	5	1	3	1	4	4	9	5	6	3	48	56	1088	.. 45.94
....	1	...	3	2	...	...	2	...	...	2	1	...	11	4	3	6	2	4	5	1	6	6	5	4	...	40	57	1237	.. 42.37
....	...	...	1	...	1	...	1	1	1	3	...	1	9	2	1	1	4	3	2	8	3	4	4	1	...	34	42	1922	.. 26.14
....	...	2	1	...	...	1	4	3	1	...	1	1	14	6	1	...	3	2	4	7	8	5	4	2	2	44	58	1033	.. 48.40
....	4	5	1	1	2	3	5	2	2	1	...	...	26	6	2	5	6	3	5	3	2	4	7	4	1	48	74	1472	.. 37.38
....	1	1	...	2	2	2	2	3	3	4	2	...	22	8	5	1	4	1	3	2	6	2	4	3	4	43	65	1380	.. 16.09
....	...	...	...	1	2	1	...	...	2	2	2	...	10	1	...	...	1	...	...	6	5	4	1	3	2	23	33	2068	.. 9.70
	8	10	8	10	7	8	16	13	15	20	12	3	120	51	35	33	40	34	33	47	58	58	59	48	25	520	640	17150	

Deaths from Convulsions in Charleston, South Carolina, amongst the White, Black and Colored Inhabitants, during a period of fourteen years.

Year.	WHITES.													BLACKS AND COLORED.													Total deaths from Convulsions amo'gst Whit's, Bl'ks and Colored.	Total deaths from all causes, Whi's	Total deaths from all causes, Bl'ks and Col'd.
	Jan...	Feb...	Mar...	April..	May..	June..	July...	Aug...	Sept...	Oct...	Nov...	Dec...	Total..	Jan...	Feb...	Mar...	April..	May...	June..	July...	Aug...	Sept...	Oct...	Nov...	Dec...	Total..			
1846............	...	...	...	1	...	...	2	3	...	...	1	1	8	1	...	1	...	...	1	1	3	3	4	1	3	17	25	258	[illegible]
1847............	...	...	...	1	...	...	2	1	1	1	1	...	7	2	...	1	...	2	1	...	2	2	...	1	11	22	29	218	[illegible]
1848............	...	...	...	...	1	1	1	...	1	...	3	1	8	...	...	...	...	1	3	3	3	...	1	1	...	12	20	307	[illegible]
1849............	1	...	...	1	1	1	1	...	2	1	...	...	8	1	2	...	1	1	1	1	...	3	2	...	...	12	20	429	[illegible]
1851............	...	...	1	...	...	...	1	1	...	...	1	1	5	3	2	1	1	2	4	1	3	2	1	...	1	21	26	389	[illegible]
1852............	1	1	...	1	1	2	2	2	2	2	...	3	16	1	2	1	1	3	1	...	8	...	1	2	3	23	39	861	[illegible]
1854............	...	...	2	2	...	1	2	4	6	4	...	...	21	...	2	3	1	3	3	4	6	12	2	2	3	41	62	1120	[illegible]
1855............	...	..	1	1	1	1	2	2	1	1	1	2	13	6	4	2	2	6	...	4	4	1	1	1	2	33	46	402	[illegible]
1857............	1	...	2	2	3	3	4	3	4	...	1	...	23	...	3	5	4	4	5	3	3	4	1	1	3	35	58	496	[illegible]
1858............	1	...	1	2	2	6	3	2	7	2	7	2	35	1	2	4	2	1	...	2	2	4	7	1	1	27	62	1252	[illegible]
1859............	...	2	1	...	3	1	3	3	...	1	2	2	18	5	3	3	2	7	3	4	4	1	1	1	...	34	52	413	[illegible]
1860............	1	...	2	...	1	3	5	8	4	3	2	3	32	2	3	2	3	4	1	4	2	2	1	—	...	24	56	719	[illegible]
1861............	3	1	1	4	8	3	5	...	...	1	...	3	26	2	5	2	...	3	7	3	3	...	...	1	...	26	52	656	[illegible]
1865............	...	...	...	2	...	7	6	4	3	1	1	1	25	1	...	...	...	14	13	12	10	8	6	7	4	75	100	560	[illegible]
Total...........	8	4	11	17	21	29	39	33	31	17	20	19	245	24	28	25	17	51	43	42	53	42	28	19	31	402	647	8080	[illegible]

From the preceding tables, the following conclusions may be drawn:

1st. During a period of 14 years, in Charleston, South Carolina, amongst the whites, the largest number of deaths from Traumatic Tetanus, occurred during the months of June, September and October, the total for these three months being 16 out of 39 for the entire period: amongst the blacks and colored the largest number of deaths occurred during the months of March, April, July, October, November and December, 61 deaths occurring during these six months out of 93 deaths during the entire period. It is evident, therefore, that we can trace no special relationship between the climate and the occurrence of Traumatic Tetanus from these mortuary statistics furnished by Charleston, South Carolina.

2d. The total number of deaths from Traumatic Tetanus, occurring amongst both races during this period was 132, out of a grand total of 17,150 deaths from all causes; or one death from Traumatic Tetanus in 129 deaths from all causes.

3d. The deaths from Traumatic Tetanus were relatively much more frequent amongst the blacks and colored.

Thus, amongst the whites during a period of 14 years, 39 deaths from Traumatic Tetanus occurred, out of a total of 8080 deaths from all causes, or one death from Traumatic Tetanus in 207.1 deaths; amongst the blacks and colored, during the same period 97 deaths from Traumatic Tetanus, in 9020 deaths from all causes, or one death from Tetanus in 97 deaths from all causes. This fact indicates that the black and colored race, is more liable to Traumatic Tetanus than the white race.

4. During a period of 14 years, the deaths from Trismus Nascentium, amongst the whites, numbered 120, and amongst the blacks and colored 520; total deaths amongst blacks and whites 640, out of a total of 17,150 deaths from all causes; or one death from Trismus Nascentium in 26.1 deaths from all causes.

5. If the deaths from Trismus Nascentium be added to those of Tetanus, we have a total of 772 deaths, or one death from these various forms of Tetanus in 22.2 deaths from all causes.

6. The largest number of deaths from Trismus Nascentium occurred amongst the whites in the months of July, August, September, October and November, 76 deaths out of 120, occurring during these months; amongst the blacks and colored, the largest number of deaths occurred during the months of January, July, August, September, October and November, 332 deaths occurring in these months out of a total of 520 deaths.

7. Trismus Nascentium, in like manner with Traumatic Tetanus, caused a much greater number of deaths amongst the colored and black race than amongst the whites; thus, amongst the whites, out of a total of 8080 deaths from all causes, 120 were

caused by Trismus Nascentium, or one death in 67.3; amongst the blacks and colored this disease caused 520 deaths, or one death in 17.2 deaths from all causes. It is evident, therefore, that Trismus Nascentium is much more frequent and fatal amongst the black and colored race.

8. Convulsions and spasms, *so called*, caused during the period of 14 years, 245 deaths amongst the whites, and 402 deaths amongst the blacks and colored, giving a total of 647 deaths: or one death from convulsions and spasms amongst the whites in 32.5 deaths, and one death amongst the blacks and colored in 22.4 deaths, and one death in both whites and blacks and colored in 26.5 deaths from all causes. The largest number of deaths from convulsions and spasms, occurred both amongst the white and black races during the months of May, June, July, and August; and the increased mortality from these convulsive diseases, may therefore be referred to the increase of temperature and the more potent action of malaria.

The following results of my examination and consolidation of the mortuary statistics of New Orleans, Louisiana, will illustrate the relative mortality caused by Tetanus, Trismus Nascentium and Convulsions, in this city, situated on a low, alluvial, damp malarious plain, on the banks of the Mississippi, in the sub-tropical zone of North America.

During a period of 21 years, including the years, 1847, 1848, 1849, 1852, 1853, 1856, 1857, 1858, 1859, 1860, 1863, 1864, 1865, 1866, 1867, 1868, 1869, 1870, 1871, 1872, 1873, the total deaths from all causes in New Orleans, amounted to 165,435; of this grand total during the periods just specified, Tetanus caused 1727 deaths, or 1 death in 95.7 from all causes; Trismus Nascentium, caused 3627 deaths, or 1 death in 45.6, deaths from all causes; Tetanus and Trismus Nascentium, together, caused 5354 deaths, or 1 death in 30.9 deaths from all causes; convulsions, caused 6364 deaths, or 1 death in 25.9 deaths from all causes; Tetanus, Trismus Nascentium and Convulsions, caused during the period specified 11, 715 deaths, or 1 death from these convulsive diseases, in 14.1 deaths from all causes.

The relative prevalence of Tetanus, Trismus Nascentium and Convulsions, amongst the white and colored race, may be gathered from the following table embracing the years 1849 and 1850.

Deaths from Tetanus each month, amongst White, Black and Colored Inhabitants of New Orleans, during the years 1849 *and* 1850.

	WHITES.													BLACKS AND COLORED.														
Years.	January	Febr'ary	March...	April.....	May	June	July	August..	Sept......	October.	Nov.......	Dec	Total deaths f'm Tetanus.	January	Febr'ary	March...	April.....	May	June	July	August..	Sept......	October.	Nov.......	Dec	Total deaths f'm Tetanus.	Total deaths from all causes Whites.	Total deaths from all causes Blacks.
1849..........................	2	3	2	2	1	6	3	2	4	3	6	8	42	1	1	...	2	3	...	...	2	2	1	4	1	17	7970	1876
1850..........................	6	3	5	1	4	8	1	4	6	4	9	3	54	1	2	2	1	3	1	1	3	...	...	2	1	17	6336	1500
Total..........................	8	6	7	3	5	14	4	6	10	7	15	11	96	2	3	2	3	6	1	1	5	2	1	6	2	34	14360	3376

Deaths from Trismus Nascentium each month, amongst the Whites, Blacks and Colored, of New Orleans, 1849 *and* 1850.

																											Total Tet. and Trismus.	Total deaths all causes.
1849..........................	12	8	6	5	6	2	10	18	14	7	10	15	113	9	1	...	7	4	3	3	9	5	4	5	9	59	231	9846
1850..........................	7	14	7	6	8	5	13	9	15	8	12	10	114	3	3	2	2	5	3	7	7	9	5	1	5	49	234	7836
Total..........................	19	22	13	11	14	7	23	27	29	15	22	25	227	12	4	2	9	9	6	10	16	11	9	6	14	108	465	17682

Deaths from Convulsions each month, amongst Whites and Blacks in New Orleans, 1849, 1850.

																											Total deaths, Convulsi's.	Tot. deaths Tet. Tris. Nes. & Con.
1849..........................	30	13	31	28	20	17	22	20	19	21	13	16	248	6	3	5	12	2	8	2	4	1	9	1	8	62	310	541
1850..........................	18	12	12	17	23	19	12	55	39	35	31	19	291	2	4	2	3	3	2	4	13	9	7	7	4	59	350	584
Total..........................	48	25	43	45	43	36	35	77	58	56	44	35	539	8	7	7	15	5	10	6	17	10	16	8	12	121	660	1125

Deaths caused by Tetanus, Trismus Nascentium and Convulsions each month, Total Deaths from all causes in New Orleans, during a period of 10 years, embracing the following years: 1849, '50, '52, '53, '67, '69, '70, '71, '72, '73.

Year.	Jan'y..	Feb'ry	March.	April..	May ...	June...	July...	Aug....	Sept...	Oct	Nov ...	Dec....
DEATHS CAUSED BY TETANUS IN NEW ORLEANS.												
1849	3	4	2	4	4	6	3	4	6	5	10	9
1850	7	5	7	2	7	9	2	7	6	4	11	4
1852	7	4	6	2	4	4	10	3	7	12	4	3
1853	3	5	2	2	8	2	3	3	6	5	5	5
1867	2	3	1	4	6	10	15	19	21	23	18	6
1869	7	6	5	13	16	5	11	11	13	18	12	17
1870	5	12	10	8	5	13	17	10	14	9	8	8
1871	5	5	2	4	4	9	10	9	9	9	8	5
1872	6	4	4	5	10	8	4	10	13	3	3	1
1873	4	4	6	6	8	11	15	1	4	2	7	5
Totals	49	52	45	50	72	77	90	77	99	90	86	[illegible]
DEATHS CAUSED BY TRISMUS NASCENTIUM IN NEW ORLEANS.												
1849	21	9	6	12	10	5	13	21	23	12	15	
1850	10	17	9	8	13	8	20	16	21	13	23	
1852	13	10	9	12	6	10	7	22	17	31	16	
1853	10	9	6	8	8	5	14	13	25	15	15	
1867	29	13	19	22	10	25	12	20	24	28	16	
1869	6	4	6	7	2	9	20	21	21	15	11	
1870	16	16	6	8	8	11	21	25	23	13	19	
1871	24	10	23	13	9	18	23	37	18	15	25	
1872	17	22	13	9	21	15	16	22	18	42	22	
1873	26	10	16	14	18	16	27	34	20	31	21	
Totals	172	120	113	133	104	122	174	231	210	216	183	
DEATHS CAUSED BY CONVULSIONS AND SPASMS IN NEW ORLEANS.												
1849	36	18	36	40	22	25	24	24	21	30	14	
1850	20	16	14	20	26	21	16	68	47	42	38	
1852	20	27	17	34	49	55	38	51	44	38	32	
1853	22	16	22	38	42	53	44	107	39	26	30	
1867	13	16	18	28	13	26	24	42	56	57	35	
1869	16	13	24	52	25	34	33	15	25	30	20	
1870	28	19	16	17	22	28	20	13	22	16	21	
1871	21	16	18	19	16	26	26	22	9	23	22	
1872	23	21	8	14	35	39	12	29	21	16	15	
1873	23	18	16	15	30	27	45	29	23	30	16	
Totals	222	180	189	280	280	334	282	390	307	298	243	

TOTAL MONTHLY AND YEARLY DEATHS IN NEW ORLEANS.

1849	1182	601	1395	1068	997	870	435	485	666	911	622	630	9862
1850	582	425	840	481	601	479	584	916	653	620	899	756	7836
1852	486	477	462	502	627	1163	769	883	725	957	890	752	9693
1853	581	463	456	532	671	656	2216	6201	1627	674	712	844	15633
1867	397	362	401	350	316	561	551	1039	2498	1942	959	720	10096
1869	360	323	435	590	631	560	588	451	461	520	473	609	6001
1870	494	456	634	580	651	712	529	521	904	738	596	570	7391
1871	477	381	525	471	444	585	522	592	485	478	624	475	6059
1872	447	630	430	418	713	572	483	569	425	532	430	473	6122
1873	642	556	603	600	930	562	773	498	624	713	500	504	7505
Totals	5648	4674	3153	5592	7681	6720	7450	12155	9068	8085	6605	6335	86198

From the preceding tables, consolidated from the mortuary records of New Orleans, the following conclusions may be drawn:

1st. During the years 1849 and 1850, 96 deaths were caused by Tetanus amongst the whites in a total of 14,306 deaths from all causes in this class, or one death in 149 deaths from all causes amongst the whites; 34 deaths from Tetanus occurred amongst the black and colored, in a total of 3376 deaths in this class, or one death in 99.4 deaths from all causes amongst the blacks and colored.

It is evident, therefore, that in New Orleans, as in Charleston, South Carolina, tetanus is more fatal amongst the black and colored race than amongst the whites. During the same period Trismus Nascentium caused 227 deaths amongst the whites, or one death in 63 deaths from all causes in this class: amongst the blacks and colored, 108 deaths, (or one death in 31.2 deaths from all causes in this class) were caused by Trismus Nascentium. It is therefore in like manner evident, that this form of Tetanus is relatively more fatal amongst the blacks and colored, than amongst the whites.

2d. During a period of 14 years, including the years 1849, 1850, 1852, 1853, 1867, 1869, 1870, 1871, 1872 and 1873, out of a total of 86,198 deaths from all causes in New Orleans, 842 deaths were caused by Tetanus, or one death in 102 deaths from all causes in the white, black and colored races: 1945 deaths were caused by Trismus Nascentium, or one death in 44.3 deaths from all causes; convulsions caused 3224 deaths, or one death from convulsions in 26.7 deaths from all causes.

3d. The largest number of deaths from Tetanus occurred in the months of June, July, August, September, October and November, reaching the maximum, viz: 99 in September; total for these six months 519; whilst in the remaining six months, viz: December, January, February, March, April and May, the mortality from Tetanus amounted to only 323. These facts indicate, that in New Orleans, Tetanus is influenced to a certain extent by the increase of atmospheric heat, and by the increased action of malaria, for it is most fatal in the hottest months, in which the heaviest mortality is caused by malarious diseases.

4th. The largest number of deaths from Trismus Nascentium occurred in the months of July, August, September, October, November and December, reaching the maximum 231, in August; total for these six months 1329; total for remaining six months, viz: January, February, March, April, May and June, 616. In like manner it appears, that in New Orleans, Trismus Nascentium is influenced to a certain extent by the increase of atmospheric heat and by the increased action of malaria.

5th. The largest number of deaths from Convulsions occurred in the months of June, July, August, September and October, reaching the maximum 390, in August; total for these five months, 1611; total for remaining seven months, viz: November, December, January, February, March, April and May, 1613. The vast proportion of these deaths from Convulsions, occurred amongst infants and teething children.

For purposes of comparison, I have endeavored to collect the statistics of cities situated within the interior of the Southern States, in more elevated localities than those of Savannah, Charleston and New Orleans. At a great expenditure of time and labor I have consolidated from the mortuary record of the various cemeteries of Nashville, Tennessee, and Augusta, Georgia, the following statistics. In these labors, I was ably assisted by my friend and former Assistant, Dr. John Watson Morton, Jr., (formerly Colonel and Chief of Artillery in the Cavalry Division of Lieutenant General Forrest, C. S. A.), whilst I held the position of Health Officer of Nashville, Tennessee, 1867, 1868.

Total Deaths, and Deaths caused by Tetanus, Trismus Nascentium and Convulsions, amongst the Whites, Blacks and Colored in Augusta, Ga., during a period of 50 years, 1817–1866.

Year	WHITES.				BLACKS AND COLORED.				Total deaths, all causes, wh'ts & bl'ks
	Tetanus	Trismus Nascentium.	Convulsions, Spasms.	Total deaths all causes, Whites.	Tetanus	Trismus Nascentium Spasms.	Convulsions.	Total deaths all causes, Blacks.	
1817*									46
1818									90
1819									118
1820			1						126
1821			3						127
1822									145
1823									109
1824									90
1825									127
1826									117
1827									134
1828									91
1829									94
1830									71
1831									152
1832									104
1833			1						129
1834*									75
1835			1						105
1836			1						107
1837			5						150
1838			3						95
1839			1						340
1840									93
1841			2						55
1842				71				76	147
1843	1			80				47	127
1844	1			105				22	127
1845	1		3	72	1		2	67	139
1846	1		1	89	2		10	96	185
1847			6	76			12	92	158
1848			12	113			9	123	236
1849	1		3	129	2		9	114	243
1850			24	178			15	150	328
1851			19	219			17	144	363
1852			15	255	1		13	155	410
1853	1		16	224			12	148	372
1854	1		28	384	2		16	154	538
1855	2		5	234	2		2	130	364
1856	1		25	236			18	131	367
1857	1		21	273			13	148	421
1858			21	223			13	110	333
1859	3		24	221			6	128	349
1860			21	282			9	113	395
1861	1		20	297	1		10	135	432
1862		1	19	449	1		15	189	638
1863	1		23	406	2	1	31	281	687
1864			23	589	2		21	238	827
1865			20	1313	1		26	789	2102
1866	1		7	373	2		9	468	841

Total Deaths in the City of Nashville, from all causes, consolidated by Joseph Jones, M.D., Health Officer, from all the records of the various Cemeteries, 1822 to 1867, with annual death, rate, and per cent. of deaths to living inhabitants.

Year.	Total Deaths	One death in so many Inhabitants.	[illegible]
1822	69	44	[illegible]
1823	74	46.7	[illegible]
1824	102	33.8	[illegible]
1825	71	62.7	[illegible]
1826	165	47	[illegible]
1827	129	39	[illegible]
1828	166	31.7	[illegible]
1829	208	29	[illegible]
1833	355	16.8	[illegible]
1834	175	34.9	[illegible]
1835	336	18.5	[illegible]
1836	225	28.3	[illegible]
1837	198	32.9	[illegible]
1838	185	35.9	[illegible]
1839	205	33	[illegible]
1840	222	31	[illegible]
1841	271	27.2	[illegible]
1842	214	36.6	[illegible]
1843	269	33.4	[illegible]
1844	319	27.3	[illegible]
1845	246	37.4	[illegible]
1846	380	25	[illegible]
1847	484	20.9	[illegible]
1848	569	18.5	[illegible]
1849	767	14.1	[illegible]
1850	911	12.6	[illegible]
1851	405	29.7	[illegible]
1852	559	22.5	[illegible]
1853	448	29.2	[illegible]
1854	633	20.7	[illegible]
1855	491	29	[illegible]
1856	453	32.6	[illegible]
1857	525	29.2	[illegible]
1858	518	30.6	[illegible]
1859	643	25.5	[illegible]
1860	709	21.2	[illegible]
1861	612	27.8	[illegible]
1862	802		
1863	993		
1864	1730		
1865	1711		
1866	2671		
Total Deaths	20248		

In Augusta, Georgia, up to the year 1845, the record of diseases causing death very imperfect, and no separate record of the diseases causing deaths amongst the blacks and colored, appears until 1842. If therefore we exclude the mortuary statistics from 1817 to 1845, and regard only those relating to the succeeding 22 years, viz: 1845 to 1866, inclusive, we have a total of 6645 deaths amongst the whites; 15 of which were due to *Tetanus*, or one death in 443 deaths from all causes; during the same period, "*Convulsions, Spasms and Fits*," (including Trismus Nascentium, only one death during this period being entered as such, upon the mortuary records) caused 356 deaths, or one death in 18.3 deaths from all causes· Amongst the blacks and colored during the same period, out of a grand total of 4240 deaths, Tetanus caused 19 deaths, or one death in 228.4 deaths from all causes; "*Convulsions, Spasms and Fits*," (including Trismus Nascentium, only one death being referred to this disease,) caused 240 deaths, or one death in 17.6 deaths from all causes amongst the blacks and colored: *Tetanus* caused 34 deaths in a grand total of 10,885 deaths from all causes amongst whites, blacks and colored, or one death in 320 deaths from all causes. It is evident from these statistics:

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*Record of Diseases imperfect.

First. That Tetanus caused relatively a much larger number of deaths amongst the blacks and colored than amongst the whites, in Augusta, Georgia.

Second. That Tetanus is much less frequent and fatal, both amongst the whites and colored races, in Augusta, Georgia, than in Charleston, South Carolina, Savannah, Georgia, and New Orleans, Louisiana.

With reference to the mortuary statistics of Nashville, Tennessee, I found upon careful investigation, that records had been kept by three different congregations or societies, separate from those of the large grave-yard (City Cemetery), viz: by the Catholics, and the two Hebrew Synagogues, who failed in many instances to record the diseases causing death. It was therefore impossible to obtain complete statistics showing the total number of deaths from Tetanus, Trismus Nascentium and Convulsions. The following general results were obtained by the examination of a series of years, (10 years, 1838-1848): Tetanus caused one death in 180 deaths from all causes occurring in the white, black and colored races; Tetanus was relatively twice as fatal or caused relatively to the total number of deaths, twice as great a mortality amongst the blacks and colored. Tetanus caused relatively a greater mortality in Nashville, than in Augusta, Ga., but much less than in Charleston, S. C. and New Orleans, Louisiana.

From the preceding statistics the following table has been constructed:

PLACE.	Period.	Total Deaths,	Deaths from Tetanus.	Proportion.
London, England	1850–3–4	224,515	73	1 in 3075
Ireland	1831–1851	1,187,374	238	1 in 4987
New York, U. S. America	1819–1834	83,783	112	1 in 748
Bombay, India	1851–1853	42,651	912	1 in 46.
Guy's Hospital, London	1825–1857	11,052	62	1 in 194
Philadelphia, U. S. America	1807–1827	53,004	125	1 in 424
Philadelphia, "	1827–1830	16,579	29	1 in 573
Philadelphia, "	1830–1840	49,686	51	1 in 974
Massachusetts	5 years.	104,873	55	1 in 1907
Savannah, Georgia, *Whites*	1804–1853	14,332	58	1 in 229.8
Charleston, South Carolina, *Whites*	1846–1865	8,880	39	1 in 207.1
Charleston, " *Blacks*	1846–1865	9,020	93	1 in 97.
Charleston, " *Whites and Bl'ks*	1846–1865	17,150	132	1 in 130
New Orleans, La., *Whites and Blacks*	1847–1873	165,435	1727	1 in 95.7
New Orleans, La., *Whites*	1849–1850	14,306	96	1 in 149
New Orleans, La., *Blacks*	1849–1850	3,336	34	1 in 99.4
Augusta, Ga., *Whites*	1845–1866	6,645	15	1 in 443
Augusta, Ga., *Blacks and Colored*	1845–1866	4,240	19	1 in 228
Augusta, Ga., *Whites, Blacks and Colored*	1845–1866	10,884	34	1 in 320
Nashville, Tenn., *Whites, Blacks and Colored*	1838–1848			1 in 180

The preceding statistics, justify the conclusion that Tetanus is most common and fatal in low, moist, hot, malarious situations.

The fact that Tetanus is now much less common in Military and Naval Service, appears to be attributable, mainly to improvements in the hygienic and sanitary regulations of armies, ships and hospitals, and in the treatment of the wounded.

Dr. Lind* who was physician to the English fleet, about the middle of the last century, has recorded the remarkable fact, that after amputation, five cases out of six, generally proved fatal from an attack of Lock-Jaw, whereas at the present day, in military and naval practice the disease is comparatively rare.

There are facts to show, that foul air tends powerfully to promote the occurrence of this disease. Thus in the Dublin Lying-in-Hospital, by means of improved ventilation, etc., the mortality from tetanus in the infants, was reduced to nearly one-tenth of what it had been. Tetanus seems at times to assume an almost epidemic character. Dr. Benjamin Ward Richardson says, that he knew one surgeon, whose operations, it once followed for some weeks, as though he carried the cause of it with him. In some hospitals it appears to have been much more prevalent than at others; at St. Marks, it is mentioned that amongst 1763 operations performed upon hæmorrhoids, with the ligature, there were 5 cases of Tetanus, four of which occurred in the spring of 1858, a year in which the disease was more frequent than usual; in other hospitals, from 1858 to 1865, more than 800 operations have been performed, but no case of Tetanus has resulted.*

11. Many of the changes observed in the Abdominal and Thoracic Viscera, in Traumatic Tetanus, are manifestly due to the mode of death, and the compression of the organs during the violent spasms. The congestions of the pharynx and glottis, appear to be caused by spasms of those parts, consequent upon the exalted reflex actions of the medulla oblongata and upper portions of the spinal cord.

In some cases, however, morbid appearances have been observed in different portions of the digestive canal, which cannot be viewed either as the results of the malady, or of the mode of death, but must be considered either as sources of irritation, or as concurring aids to irritation.

A chronic case of idiopathic tetanus, recorded in the Philosophical Transactions for the year 1764, was apparently caused by worms in the intestinal canal; Sauvages relates a fatal case of Tetanus, in which the intestines were perforated by worms; Mursinna, has recorded an instance of trismus in which the disease was cured by the expulsion of a single worm, ten ells in length; Dr. Thompson of Jamaica, mentions several cases of Chronic Tetanus in negro children, arising from the irritation of worms, and they were so often met with in the stomach and intestines by M. Laurent, a physician of considerable experience, at Strasbourg, that he was induced to attribute the disease in all cases, to their presence; worms are noticed as causes of tetanus, by Morgagni, Stohl, Fournier, Percy and others, whilst Baron Larrey, frequently found after death, from this disease, lumbrici in the small intestines, without any trace of inflammation; increased vascularity and inflammatory state of the mucus membranes of the alimentary canal, were found by Mr. Swann, in all the cases of Tetanus, in which he found unusual appearances of the sympathetic system; Dr. McArthur discovered inflammation of the stomach and intestines, in four fatal cases of tetanus; and Andral has recorded a case, in which on dissection, he found unequivocal marks of gastritis: such facts show the importance of making accurate examinations of the alimentary canal in this disease; and whilst endeavoring to estimate the influence of such a cause as worms, it should be borne in mind, that they are frequently present in the bodies of those who have died of various diseases, and that they are frequently present in the intestines, without inducing any disturbance of health.

It should also be considered in this connection that the most various kinds of ulcers scarcely ever give rise to tetanus; syphilitic sores, primary and secondary, tuberculous cavities, pulmonary gangrene, the intestinal lesions of Typhoid fever, and dysentery, rarely if ever develop this disease; and in glanders and farcy, snake-bite, malignant pustule, sibbiens, leprosy, small-pox and syphilis, the phenomena appear to be dependent rather upon profound changes of the blood and upon depression of the circulation, than upon nervous excitement.

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*An Essay on the Most Effectual Means of Preserving the Heath of the Seamen of the Royal Navy, 1757.

*Medical Times and Gazette. September 2d, 1865.

Such facts stand in opposition to that theory, which would regard Tetanus as resulting from the absorption of morbid secretions, or matters, from wounded and diseased surfaces. At the same time it must be admitted that changes in the constitution of the blood, may induce such a state of the nutrition of the ganglionic cells of the sympathetic and cerebro-spinal nervous system, as may predispose to the tetanic condition.

Lesions of the muscles, fractures of the bones, and even dislocation of the vertebra, which have been recorded by various observers, as Baron Larrey, Baron Dupuytren, Desportes, Fournier, Pescay, Mr. Curling and others, are clearly referable to the violent and sudden spasmodic contractions of the muscles, during the powerful spasms characteristic of severe cases of this disease.

The engorgement of the thoracic and abdominal viscera, observed after death, in certain cases of Tetanus, appear to be referable not so much to deranged circulation in these organs, but to the powerful contraction of the muscles, by which the blood is forced upon the internal organs, and also to the state of asphyxia, in which the disease so frequently terminates.

We cannot apply this explanation, to the engorgement of the capillaries of the cerebro-spinal system, because this congestion of the gray matter, is much more marked than that of the white substance and investing membranes of the spinal axis, and especially because the congestion of the nervous centres is attended in Tetanus, with those well marked alterations, upon which we have already dwelt at length.

It is also worthy of note, that the *post-mortem rigidity of the muscles is* greater in Tetanus than in any other disease, with the exception perhaps of poisoning by strychnia; whilst at the same time, the disposition in the blood to coagulate, is often delayed, and sometimes even altogether lost. This contracted state of the muscles after death from Tetanus, would therefore appear to be due to irritability remaining in the muscular fibre, after all the other phenomena of life have ceased, rather than to the action of a cause similar to that which is active in the coagulation of the blood.

Some authors have held, that Tetanus like Hydrophobia is due to blood poisoning. This view has been sustained by the fact, that a condition so nearly resembling Tetanus as to be with difficulty distinguished from it, may be caused by the direct introduction of strychnia into the blood. It is true that both in Traumatic Tetanus, and in the Tetanic Spasms induced artificially, the disease is chiefly located in the spinal cord, which is an organ, both for the *generation of nerve force*, and the conduction of impressions to and from the brain. In tetanus and in the action of strychnia, there is increased action in the ganglionic cells of the spinal cord, as manifested in the great exaltation of reflex excitability. It is well known that in some cases of disease, in which the amount of blood in the cord is increased, very small quantities of strychnia produce the characteristic phenomena of stiffness in certain muscles, and of augmented reflex excitability. These facts, as well as the results of the experiments and post-mortem examinations of Schroeder Van Der Kolk and of myself, which will be examined more fully hereafter, warrant the conclusion that in cases of strychnia poisoning, as well as in Tetanus, the amount of blood in the cord and the excitability of the organ are both increased. According to Bernard,* Strychnia produces convulsions by exaggerating the sensibility of certain parts, it also causes reflex movements; the point of departure being in the sensitive system, for when the posterior roots of the nerves are cut, the animal dies without convulsions. An experiment performed by Professor Hammond,† of New York, and Dr. S. Wier Mitchell, of Philadelphia, appears to show that the action of

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*Leçons sur les Effets des substances toxiques Médicamenteuses, Paris, 1857, p. 386,

† Am. Jour. Med. Science, July, 1859,

Strychnia is to destroy the nervous excitability from the centre to the periphe
that its influence must therefore be first excited on the spinal cord. Under the
a large frog, whose left sciatic nerve was previously divided, a few drops of
solution of strychnia were introduced. Tetanic spasms ensued in two minutes
forty-five minutes the nerves were irritated by galvanism; that of the left side
had been cut responded energetically, while no motions could be produced throu
uncut nerve. The former remained excitable for two hours later.

The spasms excited by strychnia, therefore, as well as those of Tetanus, are p
due to similar causes, viz: the congestion of the cord and increased nutrition an
tional activity of the ganglionic cells; and in both cases the congestion may be i
primarily by derangement of the vaso-motor nerves. It is evident, therefore, th
similarity of symptoms in the two conditions do not justify the adoption of the t
that Tetanus is caused by a poison in the blood.

The increased prevalence of Tetanus in low, hot, moist, malarious regions, m
accounted for upon the same principle as the increased prevalence of Neuralgia
the same conditions, viz: derangement of the blood, and of the vaso-motor sys
nerves, and periodic congestions of the central ganglionic masses of the symp
and spinal systems.

CHAPTER IV.

ERIMENTAL INVESTIGATIONS ON THE ACTION OF PHYSICAL AGENTS, AND OF CERTAIN POISONS, UPON LIVING ANIMALS, INSTITUTED WITH THE DESIGN OF THROWING LIGHT ON THE MODE OF ACTION OF FEVER POISONS, AND ON THE PHENOMENA OF CONVULSIVE DISEASES.

perimental investigations on the action of physical agents, and of certain poisons upon animals, instituted with the design of throwing light upon the nature and mode of of unknown fever poisons, and on the phenomena of convulsive diseases. periments illustrating the action of physical agents, abstraction of blood, electricity, anical injuries of various portions of the cerebro-spinal system, introduction of air into ood-vessels. Experiments illustrating the action of poisons, as Hydrocyanic Acid on vegetables. Experiments illustrating the action of various poisons, as Prussic Acid, de of Potassium, Strychnia, etc., upon living animals. General conclusions, drawn 185 experiments with poisons. Practical applications of the results to the Therapeutics tanus.

EXPERIMENTAL ILLUSTRATIONS OF CONVULSIVE DISEASES.

e manifest influence of climate, and especially of the vicissitudes of heat and cold, oist, warm regions, in rendering the human system more liable to both Traumatic Idiopathic Tetanus, lead various writers to throw out suggestions as to the probable ndence of the disease, in a certain number of cases at least, upon some pre-existing of the nervous and muscular systems, and which disturbed states were the result rangements in the blood and excretions, and in the actions of the excretory organs, ting from the deleterious effects of the unhealthy climate. The close relations of Teta- to Hydrophobia, a disease manifestly depending upon the introduction of a specific ani- poison into the blood, also led to the belief that the former might, in like manner, result, me cases, from the generation of an animal poison, either within the blood itself, or in the wounds, or from the irritant action of retained and altered secretions and etions. This view was still farther strengthened by the discovery of certain poisons, ydrocyanic Acid and Strychnia, which, when injected into the blood-vessels, even nall quantities, are capable of exciting the most violent and fatal forms of tetanic ns.

he greater tendency of penetrating and closed wounds to cause Tetanus, has been estive of the action of some subtle animal poison, which, like that of the mad dog serpent's fang, is the more deadly the less the blood flows.

has been asked, whether the link between chilled wounds and spasmodic par- ms, may not be an animal poison, generated in the wound during the process of ng? and being animal poison, therefore poisonous in extremely minute doses, and ble of being latent in the system for long periods, and of being specially fatal to the ous system?

r. B. W. Richardson (Trans. Epidem., Soc. of London, vol. 1, p. 28), on the theory ymosis, refers to the question of Tetanus as belonging to the Zymotici. Thus, he

> n this disease, the poison, in my opinion, is first developed in the wound, as a result of nposition. Thence carried into the circulation, the new substance, without any neces- increase of its own parts, excites a Zymosis, ending in the production of an alkaloid or ine body, which has all the power of exciting symptoms of spasm, as much as Strych- itself."

Whilst this theory does not account for the occurrence of Tetanus in some cases an not in others, and does not define the connection of the acknowledged causes, c damp, vicissitudes of temperature and wound; and it is not at all necess to the rational explanation of the mode of origin of the disease; at the sa time, the phenomena of Tetanus in the human being should be illustrated by we conducted experiments upon animals, and should be especially compared with tetan spasms, artificially produced by such poisons as Strychnia and Hydrocyanic Acid

In the summer of 1854, I commenced a series of investigations, with the design o determining: First, the effects of poisons on animal temperature, secretion and excre tion, and on the nervous and muscular forces; second, the effects of poisons upon the blood and organs; third, the effects of poisons upon the physical and chemical chang after death; fourth, the relations of the changes produced by poisons, with pathologic states, and especially with the pathological conditions produced by fevers and inflammations.

As numerous facts indicate that fevers are due to special poisons, whilst at the sa time, these poisons have not been isolated, and, therefore, many of their actions a involved in obscurity, I supposed that light might be thrown upon the character and effects of fever poisons, by carefully investigating and comparing the effects of pois whose chemical constitution and relations are known. The field of experiment he opened is of boundless extent, and each experiment may be discussed in various re tions; in the present inquiry, however, I desire to present those experiments whi bear most directly upon the phenomena and pathological alterations of Tetanus and associated diseases of the nervous system.

It is important that we should first investigate the changes of temperature, circ tion, respiration, nervous and muscular actions of the organs and tissues, induced b what may be called physical or mechanical agents, in contra-distinction to the actio poisons. It is evident that we can form no distinct ideas of the effects of pois without the establishment of certain definite standards of healthy actions, to whi they may be referred. If the effects of mechanical agents upon the respiration, circ tion and temperature be determined, we have the true ground of departure for expe ments upon the action of poisons. By limiting the experiments with mechani agents to certain parts of the nervous system, or to certain organs; by combining a varying these experiments, important physiological facts and principles may be est lished, which form data for the comparison of the experiments upon poisons.

The appearance of the organs and tissues of healthy animals after death from m chanical means, should also first engage the attention; for it is evident that it wo be impossible to ascertain with accuracy the true characteristics of any patholog alteration, or determine the effects of any poison upon the animal structures, with knowing wherein they differed from the appearances of health.

PRELIMINARY EXPERIMENTS ILLUSTRATING THE ACTION OF PHYSICAL AGEN

Experiment 1: Effects of Abstraction of Blood upon Animal Temperature, and up the Color and Appearance of the different Viscera, and especially upon t Amount of Blood contained in the Blood-Vessels of the Brain and Spinal Co

Medium-sized, active, well-conditioned dog, (cross between bull and cur). Temperature surrounding atmosphere, 19° C (66°.2 F). Temperature of rectum of dog: (The bulb a glass stem of a delicate thermometer having been introduced into the rectum and retained this position until the temperature assumed a stationary point), 40°.3 C., (104°.6 F).

An attempt was made to sever the left carotid artery. As soon as the integuments we severed, the dog struggled violently for several minutes; during these struggles the tempera ture of the rectum rose 0°.22 C. The attempt to sever the carotid artery was abando until the thermometer ceased to rise, as we wished to observe the effects of mechanical eff upon the animal temperature. The thermometer did not rise above the point just mentio and remained stationary at 40°.53 C (105° F).

The left carotid artery was then severed; the blood gushed out in a full stream, and in t minutes after the severance of the artery, all signs of life were extinct. During the las blood the thermometer remained stationary at the point last indicated. Twenty-seven fluidounces of blood flowed out and coagulated in a few moments after its abstraction. The dog was then carefully suspended in the air, so as to maintain the same position that it had in the experiment, viz: standing posture; and the thermometer was allowed to remain in the rectum.

Fourteen minutes after death, temperature of the rectum still the same; the temperature of the surface, however, indicates a slight fall. In an animal like the subject of the present experiment, viz: fat, and covered with thick, sleek hair, the fall of the temperature in the rectum is necessarily slow. The following are the actual observations upon the temperature of the rectum after death: Temperature of rectum at moment of death, 40°.55 (105° F); fourteen minutes after death, 40°.55 C; twenty-six minutes, 40°.50 C.; forty-nine minutes, 40°.25; fifty-five minutes, after death, 40° C (104° F); eighty-six minutes, 39°.25; ninety-nine minutes, 38°.85 C; one hundred and forty-six minutes, 37°.75 C; three hundred and twenty-six minutes, 33° C. (91°.4 F); four hundred and thirty-six minutes, 31°.1 C.; thirteen hundred and eighty minutes after death, 23° C. (73°.4 F). During the first four hundred and thirty minutes after death, the temperature of the dog fell 19°.45 C. (35°.0 F). During the twenty-six minutes immediately following death, the loss of temperature was 0°055 C., or 0°.0046 C. per minute, during the succeeding twenty-three minutes, 0°.25 C., or 0°.0104 per minute; during the next six minutes 0°.25 C., or 0°.415 per minute; next thirty-one minutes, 0°.75 C., or 0°.024 per minute; next thirteen minutes, 0°.39 C., 0°.030 per minute; next forty-seven minutes, 1°.107 C., 0°.023 per minute; next one hundred and eighty minutes, 4°.75 C., 0°.026 per minute; next nine hundred and fifty minutes, 8°.1 C., 0°.0085 per minute.

The next morning, twenty-three hours after death; the thermometer in the rectum stood at 23° C., whilst the atmosphere of the room indicated very nearly the same degree, viz: 22.°6C. The last determination, therefore, is involved in some doubt, as no observation upon the temperature was made during the night. The slow rate of cooling was, without doubt, due to the heavy coating of hair on this dog.

Autopsy twenty hours after death.—The blood-vessels of the arachnoid, dura-mater and pia-mater contained but little blood, and the brain presented a pale anæmic appearance. The spinal cord was exposed throughout its entire length, and presented a similar bloodless appearance; the stomach, although containing matters in a state of partial digestion, presented a pale, bloodless appearance, both upon the exterior and interior. Careful colored drawings were made of the brain and spinal cord, and viscera, for future use and comparison.

Experiment 2: Effects of Abstraction of Blood.

Thin, medium-sized dog; Temperature of surrounding atmosphere, 19°.5 C. (67°.1 F). Temperature of rectum, 40°.15 C. (104°.28 F). The thermometer was placed in the rectum so as to occupy the same relative position as in the preceding experiment, and the dog was held by the aid of several assistants in the standing posture. An incision was made in the thigh of the hind leg, just above the knee joint, when the sciatic nerve was cut; the animal exhibited signs of pain, and struggled violently for several moments; during these struggles there was a slight rise in the thermometer of 0°.05 C. The femoral artery was then severed; the bleeding was slow; the blood coagulated rapidly, and twenty minutes after the large artery was severed, a fibrinous coagulum had completely filled up the artery, and arrested the bleeding; when this plug was pulled out, the blood again flowed freely; similar clots formed in the smaller arteries. Twenty-five minutes after the commencement of the bleeding, the animal appeared to be very faint. Could not stand up. Respiration labored and panting; drew long sighs, and emitted several feeble cries; and finally died, thirty-five minutes after the commencement of the bleeding.

During the bleeding, the thermometer remained stationary, and, at the momant of death, it indicated a temperature of 40°.2 C. (104°.4 F). Twenty-two fluidounces of blood were lost before death. The thermometer in the rectum indicated an almost immediate fall in the temperature after death. The following are the actual observations on the temperature. Temperature of rectum at moment of death, 40°.2 (104°.4 F.); 25 minutes after death, 38° C., (100°.4 F); 38 minutes after death, 37°.75 C., (99°.9 F.); 85 minutes after death, 36° C., (96°.8 F.); 265 minutes after death, 31°.33C., (88°.4 F.); 383 minutes after death, 29°.25 C., (84°.6 F).

The rate of cooling was as follows: During the first twenty-five minutes after death, the thermometer fell 2°.2 C., or 0°.088 C. each minute; during the following 13 minutes, 0°.25 C., or 0°.019 C. per minute; during the following 47 minutes, 1°.75 C., or 0°037 per minute; during the following 180 minutes, 4°.87 C., or 0°027 C. per minute; during the following 108 minutes, 2°.08 C., or 0°.019 C. per minute. During the first 373 minutes after death the temperature of the rectum fell from 40°.2, to 29°.25; loss 10°.95 C., (19°.8 F).

The next morning, twenty hours after death, the thermometer in the rectum indicated a temperature of 22° C., whilst the temperature of the atmosphere was 22°.6 C. The temperature of the surrounding atmosphere had risen during the morning, from the kindling of a in the adjoining room.

Autopsy twenty hours after death.—Blood-vessels of brain and spinal cord and their me branes contained but little blood, and presented the same pale appearance as in the prec ing experiment. The lungs presented a yellow and light reddish, mottled color; they were very light, and the blood-vessels contained but little blood. Liver light-colored and less. The external surface of the stomach was pale; it contained partially digested the mucus membrane was corrugated, and of a light yellow, and light reddish, brownish color. The intestines, both upon the external and internal surface, present light yellow and whitish appearance. In this case also, carful colored drawings were served of the spinal cord and viscera.

Experiment 3: Illustrating the Effects of Electricity upon Living Anim

Small female pointer. Temperature of surrounding atmosphere, 26° C., 78°.8 F. shocks from a large Leyden Jar, of the capacity of one gallon, were passed through and through the medulla oblongata, through also from one external meatus auditorius other, from eye to eye, from the nose to the commencement of the spinal cord, and from side to side, of the neck in the region of the medulla oblongata.

The first strokes appeared to produce great pain, the dog cried out, and then sensible, and the shocks from the Leyden Jar then produced no effect, except a very convulsive movement, and spasms of the muscles of the back and neck, causing the back of the neck.

Shocks from the Leyden Jar, charged continuously by a large *plate glass* electrical were thus passed rapidly through those regions for 50 minutes, and during this time thermometer, which stood in the rectum, before and at the time of the commencement the experiment, at 41°.2 C., 106°.2 F., did not rise, but, on the contrary, slowly and at the end of this time, stood at 40°.6 C., 105°.1 F., showing a loss of 0°.6 C.

Forty minutes after the cessation of the electrical shocks, (ninety minutes after shock), the dog recovered from his stupor, raised its head and looked around; at this time temperature of the rectum was 40°.4 C.; showing that it had continued to descend after cessation of the shocks, and during the last 40 minutes, had lost 0°.2 C.

Two and a half hours after this observation the dog was completely restored to cons ness, and was capable of walking about. Temperature of rectum at this time, 40°.4 C.; temperature after the return of consciousness, remained stationary up to this time, and g ually ascended, and three hours after this observation, stood at 40°.45 C.

At this time, 5½ hours after the first experiment, shocks were again passed through head and neck in various directions, as before; the shocks appeared to exert less effect, the dog appeared to suffer less, and insensibility was not reproduced as fully as in the experiment.

The temperature of the rectum, as in the first experiment, descended during the pass the shocks through the brain and medulla oblongata, and in fifteen minutes stood at 40 showing a loss, in this time, of 0°.05 C.

The dog was now released from the operating table; It appeared to be very feeble, scarcely walk, muscles trembled, and it hung its head down. The animal subsequently ered its usual strength.

Experiment 4: Illustrating the Effects of Electricity, (Interrupted Magneto-E Current) upon Animal Temperature.

Passed a strong interrupted magneto-electric current, generated by the revolution armed keeper around the poles of a large magnet, through from one hand to the other.

In the left hand I grasped the bulb of a delicate thermometer, and in the right axil bulb of another thermometer was placed, and so arranged as to express the temperat the surrounding parts. Previous to the passage of the interrupted current, the temper was carefully determined: Temperature of atmosphere, 25°.6 C., 78°.2 F.; of left hand, C., 99°.5 F.; of right axilla, 38°.8 C., 101°.9 F.

After the passage for seven minutes, of as strong a current as I could well bear, there a very slight rise in the thermometer in the axilla, but none whatever in the thermome the hand.

During the passage of the electrical excitement, the moisture of the skin was increased respiration remained unaltered, whilst the pulse was slightly increased in force and sl diminished in frequency. After the cessation of the electrical excitement, the pulse sl increased in frequency.

After twenty minutes, the current was again passed, exciting, as in the preceding ex ment, violent twitchings of the muscles of the arms and chest; no effect was produced

ture of either hand or axilla,—they remained stationary; and no effect was pro-
the respiration.

t 5 : Illustrating the Effects of Strong Magneto-Electric Currents upon a Living Animal.

ng, male cur dog, fat and in good condition. Temperature of atmosphere, 27° C.,
emperature of rectum of dog, 41° C., 105°.8 F.

ure of surface of large muscles of back, (the skin being cut, and the bulb of a
r introduced), 38° C., 100°.4 F.

ure of surface of large muscles of fore-leg, (the bulb of the thermometer in like
ig introduced through the skin), 38° C., 100°.4 F Each thermometer was placed
s of a careful assistant, and retained continuously in the same position. Incisions
nade through the skin in the neck at points opposite the position of the medulla
and the terminal wires of a powerful electro-magnetic battery thrust through these
to the muscles.

ge of the interrupted magneto-electric current produced violent convulsions and
he muscles. During these convulsions there was a gradual rise in the tempera-
rectum, and at the end of eighteen minutes the thermometer in this position
.8 C., 107°.3 F., showing a rise during this time, of 0°.8 C; the temperature of
of the muscles of the loins and fore-leg also rose slowly, and at the expiration of
e temperature of the muscles of the loins was 38°.33 C., 101° F., showing an in-
°.33 C.; and the temperature of the surface of the large muscles of the fore-leg,
1°. 3 F., showing an increase of 0°.5 C.

erature of the rectum continued slowly to rise, and at the end of four minutes,
C., 107°.6 F. The thermometers were now withdrawn on account of the violence
ns and struggles of the dog.

rical currents excited, in addition to the violent convulsive motions in all parts of
profuse secretion of saliva—several ounces flowed from the mouth of the dog;
s were also attended by evacuation of the fæces and urine.

nometers were again replaced as soon as the violent struggles subsided, which
in a few moments after the discontinuance of the electrical excitement.

elapse of twelve minutes, the interrupted magneto-electric current was again
h greater energy. At the moment of the application, temperature of rectum 42°.1
.; of muscles of loins, 38°.5 C., 101°.3 F.; of muscles of fore-leg, 38°.75 C.,

uscular contractions were again excited, and at the end of five minutes the ther-
the rectum stood at 42°.2 C., 108° F., showing a rise of 0°.1 C., whilst the tem-
the muscles of the loins was 39° C., 102°.2 F., showing an increase of 0°.5 C.

ks were then passed through from the roof of the mouth to above the position of
oblongata; from the roof of the mouth to the sacrum; these shocks produced
tanic spasms of all the muscles, and death followed in a few seconds.

ture of the rectum at the moment of death, 42°.4 C., 108°.3 F., showing an increase
e violent convulsions, of 0°.2 C. Temperature of the surface of the loins, 39° C.,
howing no increase.

erature commenced to fall immediately after death, and at the end of five minutes
ature of the rectum stood at 42°.2 C., and that of the muscles of the back, at

wing are the changes of temperature noted after death: Temperature of rectum
death, 42°.4 C.; of muscles of loins, 39°; 5 minutes after death, rectum, 42°.2 C.,
C.; 30 minutes, rectum, 41°.27 C., muscles of thigh, 37° C.; 45 minutes, rectum,
s, 36°.25 C., thigh, 36°.25 C.; 75 minutes, rectum, 40° C., loins, 36° C., thigh,
5 minutes after death, temperature of rectum, 35°.4 C., of loins, 33°.75 C., of
C.

he first 5 minutes after death, the rectum lost 0°.2 C., or 0°.04 C. per minute; next
, 0°.13, or 0°.005 per minute; next 15 minutes, 0°.27, or 0°.019 per minute; next
, 1° C., or 0°.033 per minute; next 150 minutes, 4°.6 C., or 0°.03 per minute.

inutes, the rectum lost 7° C., 12°.6 F., and in the same period, the muscles of the
°.25 C., and of the thigh, 7°.2 C.

me of the last observation, three hours and forty minutes after death, the tempera-
atmosphere was 28°.5 C. Cadavaric rigidity well marked at that time.

em Examination, 4 hours after death: Strong electro-magnetic currents passed in
tion, from the nervous centres to the extremities, and through the individual mus-
ced no perceptible contractions.

s of the skin and muscles were filled with dark, purplish, almost black blood,
ulated slowly and imperfectly; the clot was large and soft, and the separation of

the serum was not so perfect as is usual in the case of the blood of healthy dogs. Under the microscope no alterations were observed in the structure of the colored blood-corpuscles.

Head: The blood-vessels of the dura-mater were filled with black blood. Blood-vessels of pia-mater filled with dark, almost black venous blood.

The spinal cord and its membranes were exposed throughout their entire length; blood-vessels of the fibrous sheath of the spinal cord, and of the nutritive membrane, filled with dark blood, and in many places it appeared that some blood had been effused upon the surface of the cord in the cervical portion of the position at which the nerves are given off which supply the fore-legs.

The dark color of the blood in the brain, spinal cord, and in all parts of the body, appears to have been due to the effects of the electrical excitement in arresting respiration during its passage through that portion of the medulla oblongata which presides over the respiratory function, and by the powerful *tetanic spasms* of the muscles of respiration, resembling in all respects those produced by Strychnia.

Large blood-vessels of stomach, filled with dark purplish blood, and although filled with matters in process of digestion, the mucous membrane was pale. Small intestines presented a normal appearance; the exterior surface, as well as the internal mucous surface was pale. Liver, blood-vessels filled with dark blood; gall bladder filled with bile; supra-renal capsules not congested with blood, normal in appearance; bladder firmly contracted and void of urine.

Lungs greatly congested with blood, presenting a dark purplish appearance; Thymus and Thyroid glands unusually large, and greatly congested with blood.

After careful microscopical examination of the cerebro-spinal and sympathetic nervous structures, and especially of the ganglionic cells, with various powers, I discovered no alterations which could be referred to the action of the interrupted electrical currents.

Experiment 6; Effects of Mechanical Injury of Cerebro-Spinal Nervous System; Injury of Medulla Oblongata.

Fine, large, full-fleshed cur dog. Temperature of atmosphere 64° F. Temperature of Rectum 102° F. A sharp steel rod was placed upon the surface of the neck, above the position of the medulla oblongata, and was struck a heavy blow with an iron hammer. The steel instrument did not strike the fourth ventricle of the brain, as was desired, but wounded the left side of the spinal cord, near or about the junction with the spinal cord of the medulla oblongata, and passed through beyond the spinal column, wounding the soft parts beneath; (it is probable that the sympathetic nerve was also wounded, this point however, was not definitely settled,) the animal remained quiet, without active movement during the infliction of the injury, and the only evidence of pain, was a shivering and slight convulsive movement of all the muscles.

The thermometer in the rectum commenced to rise immediately after the infliction of the injury, in a few moments stood at 105°.50 and then as rapidly sank to 102°.75 F.

Fifteen minutes after the first injury, whilst the dog was supported in the standing posture and quiet, with the exception of slight twitchings of the muscles, the steel rod was withdrawn, and again driven by the hammer more towards the cerebellum, or rather towards its union with the medulla oblongata. Examination after death, showed that it took very much the course of the first incision, and enlarging the wound of the left side of the spinal cord, just at its junction with the medulla oblongata, it fractured the anterior portion of the atlas, and penetrated a short distance into the soft parts beneath.

For a few moments, the struggles of the dog were powerful; the animal however, in a short time, sank into a comatose condition, or rather into a powerless state. When the ball of the eye was touched with the finger, the muscles of the eyelid contracted, and the pupil although somewhat dilated, responded to the stimulus of light. During the violent struggles the thermometer could not be retained in the rectum; it was returned however as soon as they had subsided, and indicated a temperature of 103.2 F., showing a rise succeeding the second injury of 0°.45 F. The action of the heart at the time, 25 minutes after the first injury by the steel shaft, was full and regular—64 per minute; respiration, 13 per minute. Fifteen minutes after this observation, and 40 minutes after the first introduction of the steel shaft, temperature of the rectum 103° F.; action of heart, 60 per minute; respiration, 13 per minute. Twenty minutes after this observation, and 60 minutes after the first injury, the action of the heart was strong, spasmodic, irregular, 58 beats per minute. By the beats we mean the impulses of the apex against the walls of the thorax.

The beatings of the carotid arteries could be plainly seen across the large room in which the experiment was being conducted, thus indicating the violence of the action of the heart, and the same spasmodic beatings were manifested in all the large arteries of the trunk and limbs.

Respiration 13, spasmodic, and accompanied with twitchings of the muscles of the face and lips, and with spasmodic contractions of the muscles of the throat.

Temperature of Rectum, 102°.9 F.

A strong, interrupted magneto-electric current, was next passed from the roof of the mouth to the anus. Violent convulsions were excited in all the muscles of the trunk and extremities; during these convulsions the thermometer in the rectum rose from 102°.9 F. to 104°.75 F.

These strong electrical currents exhausted the irritability of the muscles rapidly, and in the course of a few minutes they ceased almost entirely to respond to the galvanic and magneto-electrical currents—the respiratory muscles ceased to act, and in a few minutes afterwards, the heart ceased to beat. The respiration and the action of the heart ceased one hour and fifteen minutes after the first introduction of the steel shaft.

Forty-five minutes after death, the thermometer in the rectum still indicated the same temperature, 104.75. Twenty-five minutes after this observation, and sixty-five minutes after death, the temperature of the rectum was 104.°0 F. showing a fall during the last 20 minutes of 0°.75 F.

The following observations were recorded upon the changes of temperature after death. Temperature of rectum at moment of death, 104°.75; 45 minutes after death, 104.75; 65 minutes after death, 104; loss in 20 minutes 0.75, or 0°.037 F.; 80 minutes after death, 103°.5 F., loss in 15 minutes 0.50, or 0.033 per minute; 200 minutes after death 99°, loss in 120 minutes 4°.5 F. or 0°.037 F. per minute.

Post-mortem Examination: three and a half hours after death, blood-vessels of dura-matter filled with dark, almost black blood, and presented an appearance similar to that of the dog previously killed by the interrupted current. The blood-vessels of the pia-mater, were in like manner filled with dark blood. The appearance of the brain after the removal of the dura-matter was carefully sketched and preserved for future comparison. At the base of the brain in the posterior border of the left lobe of the cerebellum, there was a small clot, half an inch in length, one fourth of an inch in breadth, and one eighth of an inch in thickness. The blood-vessels at the base of the brain were more congested with blood than those of the superior portions, and blood was effused between the arachnoid and surface of the base of the brain, and of the superior portions of the spinal cord. The amount of blood effused, however, was small, and no coagulation had taken place. The blood-vessels were most probably ruptured when the atlas was punctured by the steel instrument. The stomach was filled with partially digested matters, and the mucous membrane presented an injected, purplish and reddish colour. Mucous membrane of Small Intestines, pale.

Experiment 7: Division of Medulla Oblongata, Artificial Respiration.

Large, thin, lean pointer dog. Temperature of atmosphere, 58° F. Temperature of rectum of dog, 40 33, C., 104.6 F. A knife blade was quickly passed through and across the fourth ventricle, severing in two completely the medulla oblongata, and also at the same time, the vertebral arteries.

The respiration ceased immediately, a profuse hæmorrhage took place from the vertebral arteries, and in a few moments all signs of life were extinct. Several minutes after the heart had ceased to beat, and the animal was apparently dead, the thorax was opened, the heart although motionless, contracted when touched with the point of a scalpel, and as soon as artificial respiration was established, its cavities contracted and expanded as in the living animal.

Electro-magnetic currents produced contractions in the voluntary muscles which appeared to equal in force and vigor those of life. The heart continued to beat with regularity and vigor for more than half an hour, during which time the artificial respiration was maintained.

Temperature of the rectum 30 minutes after the severance of the medulla oblongata, 39°.9 C. (103.8 F.)

Loss of temperature during 30 minutes of artificial respiration 0°.43 C.; loss of temperature each minute, 0.0143. The abdomen was opened at the same time, that we might observe the motions of the intestines; and the stomach and liver, and in fact all the viscera were freely exposed to the atmosphere. This exposure of the internal organs, together with the profuse hæmorrhage greatly increased the rate of cooling in this lean dog.

Temperature of rectum 120 minutes, after severance of medulla oblongata, 35.45 C., 95°.8 F.; loss of temperature during each minute, 0.0493 C.

If we compare the results of this experiment with those of the preceding observations, we will find that the loss of temperature has been three times as great after the cessation of artificial respiration and the action of the heart. This increased loss was due to the cooling of the body by the air freely introduced during artificial respiration, and also to the free exposure of the viscera.

Temperature of the rectum 240 minutes after the severance of the medulla oblongata, 30°.55

C., loss of temperature during the last 120 minutes, 4°.9 C.; loss of temperature each minute 0.0408 C. The loss of temperature each minute during artificial respiration was only [illegible] per minute; it is evident therefore that the artificial respiration, in that it promoted the action of the heart, the circulation of the blood and distribution of oxygen, caused a certain increase of heat, which notwithstanding that it was counterbalanced by the cool air thrown in large volumes into the lungs, and also by the loss of the blood and the exposure of the warm internal organs, was nevertheless an actual increase as evidenced by the increased rate of cooling after the discontinuance of the artificial respiration.

Experiments 8, 9, 10, 11, 12, 13. 14. Repetition of Experiment 7: Division of Medulla Oblongata, Artificial Respiration.

General results similar to those detailed in Experiment 7.

Experiment 15; Introduction of Air into the Venous System; Death.

The external jugular vein of a large male bull dog was exposed, and a small incision made through the coats of the vein, and the small end of a silver blow-pipe introduced. Air was then blown forcibly into the vein, the dog gave a few spasmodic struggles and a loud cry, and died almost immediately. Air was found after death, mingled with blood in both cavities of the heart, and in many of the veins, and even in those of the brain.

Death took place as suddenly as in section of the medulla oblongata, and more rapidly than in poisoning by Prussic acid.

Experiments 16, 17, 18, 19, 20; Repetitions of Experiment 15; Introduction of air into Venous System; Death; Results similar to those recorded under 15.

If small quantities of air are gently introduced into the venous system, the animal although much enfeebled and agitated may live for several hours. When however, air is forcibly blown into the venous system, death takes place immediately, and as rapidly as in cases of poisoning with the most potent and rapid agents as Hydrocyanic acid and Cyanide of Potassium.

After careful investigation, I have been led to the conclusion, that the forcible introduction of air produces death, by arresting the circulation of the blood in the capillaries of the lungs and of the brain, medulla oblongata and spinal cord, and of the heart; and we are inclined to view the suddenness of the fatal issue, when the air is driven in with great force, chiefly to the mechanical arrest of the circulation of the medulla oblongata.

When considerable force was used in driving in the air, the organs presented a highly congested appearance, similar to that characteristic of poisoning by Hydrocyanic acid; but in the former case, the congestion was clearly referable to the effects of mechanical pressure, suddenly exerted upon the blood within its vessels, and the combination with this pressure of mechanical arrest of the capillary circulation.

The following conclusions may be drawn from the preceding experiments, illustrating the action of physical agents.

1st. Violent muscular exertion and tetanic spasms, excited by injuries of the nervous system, are attended with an increase of temperature, both in the central organs and in the muscles.

2d. The violent tetanic spasms excited by the interrupted electro-magnetic current, are attended with an elevation of animal temperature.

3d. When an animal has been killed by the interrupted electrical currents of high tension, and which have caused violent spasms during their application to the living animal, the cerebro-spinal nervous system (brain, medulla oblongata and spinal cord,) is congested with blood, and this congestion extends not merely to the investing membranes, but is well marked in the nervous structures, and especially in the ganglionic tracts of the brain, medulla and spinal cord.

4th. The temperature progressively falls after death from injuries of the nervous system, from hæmorrhage, from electricity and from the injection of air into the venous system, and the rate of cooling of an animal after death from these causes, appears to be dependent upon several circumstances, as the temperature of the surrounding medium, the size and condition of the animal, whether lean or fat, and the character of its covering, whether wool or hair and whether thick or thin.

These facts are of interest in their connection with those cases of Tetanus, Acute Rheumatism and Yellow Fever, in which observers have recorded a rise in the temperature after death.

We will proceed in the next place, to present certain observations from our experimental investigations, upon the action of poisons, instituted with the design of throwing light upon the nature and mode of action of unknown fever poisons, and upon the phenomena of inflammation, which may throw light upon the nature and treatment of spasmodic diseases.

EXPERIMENTS UPON THE ACTION OF PRUSSIC ACID (HYDROCYANIC ACID) AND CYANIDE OF POTASSIUM UPON PLANTS.

The plant selected for these experiments was rice, (*Oriza Sativa*). If grains of rice be placed in water, they will, if the water be of the proper temperature germinate, and the plants will grow several inches in length in the water, without the addition of any extraneous matter. During the period of the germination and growth of the rice, we have a favorable opportunity of testing the effects of various poisons, simply by adding them to the water.

Experiment 21; Action of Hydrocyanic Acid on Rice.

Ten drops of officinal Hydrocyanic Acid were added to half a fluidounce of spring water, in which the rice seeds had been placed, in an open glass vessel.

The Hydrocyanic Acid retarded germination for several days, but did not arrest the final development of the young plants. The degree of retardation was determined by conducting simultaneously experiments with rice and pure water.

Experiment 22: Action of Hydrocyanic Acid upon Rice in Closed Vessels.

When the rice seeds and dilute solution of Prussic Acid were put in a partially covered glass vessel, with sufficient atmospheric air for germination, they did not germinate.

When the grains were removed from this solution, with very few exceptions they were incapable of germination, although originally perfect.

The experiments were performed in the month of June, in an upper, well ventilated room, where the temperature and light were most favorable for a rapid and vigorous germination and growth, and were repeated upon more than one hundred grains of rice.

If we compare the two experiments, and consider the surrounding circumstances, it is evident that the different results were due to the fact that when the rice was subjected to the action of dilute Prussic Acid in open vessels, the poison, from its volatile nature, was evaporated in great measure, before it produced any deleterious effects upon the rice; in the confined space, on the other hand, whilst the seeds had all the essential conditions of germination, viz: heat, moisture, and a sufficient, if not abundant supply of oxygen, in the confined air, still the absorption of the Prussic Acid continued unimpeded, and arrested the process of germination in its earliest stages, for the seeds, in almost every instance, presented upon the exterior an unaltered appearance.

Experiment 23: Action of Hydrocyanic Acid upon Germinated and Growing Rice.

When dilute Hydrocyanic Acid was added to the water in which the young shoots of rice were growing, it arrested the growth and caused death in periods of time corresponding with the amount of acid added.

This experiment was repeated upon more than one hundred stalks of growing rice, with similar results.

Action of Cyanide of Potassium upon Plants.

In the experiments with this salt, as well as in those of Hydrocyanic Acid, rice was the plant selected, and the surrounding conditions of temperature were the same.

Experiment 24: Action of Cyanide of Potassium upon the Germination of Rice.

Both in closed and unclosed vessels, solutions of Cyanide of Potassium arrested completely the process of germination. The word *arrested* is here used, because it is difficult in such experiments to affirm that not a single change took place in the organic elements before the complete arrest of the process; it is certain, however, that if any of the numerous changes of germination took place, they did not proceed far. When the seeds thus acted upon by Cyanide of Potassium were transferred to pure water, in no instance did generation take place; they simply underwent slow decay.

This experiment was repeated, with the same result, upon more than one hundred rice seeds.

Corresponding experiments were carried on at the same time with pure water.

Experiment 25: Action of Cyanide of Potassium upon Growing Rice.

Solutions of Cyanide of Potassium in every instance arrested the growth and caused the death of the growing rice; and the rapidity of its action corresponded with the amount of the poison added.

These experiments were in like manner repeated upon more than one hundred stalks of growing rice.

The following conclusions may be drawn from the preceding experiments:

I. Plants, as well as animals, may be destroyed by certain mineral and vegetable substances denominated poisons.

II. As the vegetable kingdom is without nerves, muscles, or any special circulatory apparatus similar to the automatic apparatus of animals, it is evident that these poisons must act upon the individual living cells composing the vegetables subjected to their action.

III. As the living, component cells of the vegetable kingdom are capable of elaborating distinct products from the surrounding nutritive materials, and as this power is destroyed by poisons, we must conclude that the functions of secretion, growth and nutrition may be influenced directly by poisons, without the intervention of the nervous system.

IV. As, therefore, poisons may act directly upon the individual living cells of vegetables, arresting the process of germination in the seed, and of the acts of secretion, nutrition and growth in the fully formed cells; it is reasonable to infer that poisons may act upon the individual living cells of animals. Thus poisons may act directly upon the muscular fibre, or upon the ganglionic cells of the sympathetic and cerebro-spinal system, or upon the secreting and excreting cells of the liver and kidney, or upon colored and colorless corpuscles of the blood.

We will examine experimentally, in the next place, the action of Hydrocyanic Acid, Cyanide of Potassium and other poisons on cold-blooded animals.

ACTION OF HYDROCYANIC ACID ON COLD-BLOODED ANIMALS.

Experiment 26: Action of Prussic Acid upon Siren Lacertina.—Linnaeus.

I placed a large male *Siren Lacertina*, one and a half feet in length, and recently captured from a rice field in Liberty county, Georgia, in a glass jar, and after pouring over its head, gills and back, three fluiddrachms of the officinal solution of Prussic Acid, [U. S. P]., added twelve fluidounces of pure water. The experiment was performed in the early part of June, when the weather was warm, the thermometer indicating during the day, an average temperature of 80° F.; at this temperature, the motions of the Siren Lacertina, are active and powerful. During the space of one hour, no special effects appeared to be produced by the Prussic Acid, except that the reptile remained more quiet than usual, and when irritated, was more quick and violent in its motions. I added fresh portions of the solution of Prussic Acid, at successive intervals of fifteen minutes, and at least, two fluidounces of the official solution of the acid, were poured over the head and gills, and into the mouth and over the back of the reptile. Two hours after the first application of the poison, the Siren commenced of its own accord to struggle violently—would leap up with great violence—the body was contorted, and the animal writhed as if in pain, and at intervals, the muscular system was seized with violent tetanic spasms. Simultaneously with the appearance of these

actions, there occurred profuse secretion of mucous from the slimy skin of the
using the water in which it was immersed to resemble thick mucilage. These strug-
nued for one hour, and then the reptile became quiet, and would struggle feebly only
used by a foreign body. The head appeared to be especially sensitive. Sensation
ower of motion gradually diminished, and four hours after the application, there
very slight movements of the feet and tail when actively stimulated, and aroused
nical means; and at the end of six hours, all signs of life were extinct.

rtem Examination: Six hours after the first administration of the poison, and just
cessation of the appearances of life, when the abdominal cavity was opened, no
ons whatever, were excited in the muscles, by the stimulus of the knife, and
al stimuli failed to excite contractions in any of the muscles. The heart had ceased
nd could not be aroused to action, either by any mechanical stimuli, or by powerful
ed electro-magnetic currents. Slight contractions were produced in the voluntary
by the electrical excitement. Blood was effused into the abdominal cavity, and
to have been poured out from some of the highly congested blood-vessels of the
canal. When the abdominal cavity was first opened, the blood was fluid, but
d in a few moments after exposure to the atmosphere. The color of the blood
o the arterial hue, after exposure to the air. Blood from the heart coagulated
d firmly When the blood drawn from the heart was examined under the micro-
majority of the colored blood corpuscles presented the usual appearance, some of
wever, were swollen, others presented irregular outlines, and in some the nuclei
to be composed of granules. The blood-vessels of the stomach and intestines were
th blood.

ent 27: *Action of Hydrocyanic Acid on Coluber Quadrivittatus.—Holbrook.*

onth of June, with the temperature of the atmosphere, about 85° F. a large active
ake, six feet in length, was secured, and the heart exposed without any other
n cutting through the integuments. Action of the heart 68 per minute. By the
of the heart, used in this connection, we always mean the number of the impulses
ricle or ventricles, [*ventricle* in reptiles and cold-blooded animals generally, and
warm-blooded animals]; and therefore, the term *action of the heart,* as now used,
ly the number of impulses, and does not give the collective expansions and con-
all the cavities.

rops of a solution of Prussic Acid were introduced within the peri-cardium, so
in direct contact with the exterior surface of the muscular structures of the

ts were manifested almost instantaneously in diminishing the force and num-
beats of the heart. Two minutes after the application of the Prussic Acid,
of the heart is 44 per minute, and becoming more and more irregular; there
erangement in the relations of the expansions and contractions of the different
venous blood is accumulating in the large veins and in the right auricle, and
contractions of the voluntary muscles of all parts of the body, but more especially
cles of respiration are commencing.

ortant to observe, that the *decided effects upon the action of the heart occurred imme-*
at the effects upon the voluntary muscles were not manifested until a sufficient length of time
for the absorption and conveyance of the poison by the blood to these structures and the
entres from which these nerves were derived.

nutes after the application of the poison to the surface of the heart, its action is
ute, and very irregular, the dilatations are much longer than the contractions—the
appears to cease all action, and then to become suddenly and spasmodically
At the end of fifty minutes, the ventricle of the heart had ceased to beat, and
be aroused by either mechanical stimuli and injuries, or the strong, interrupted
lectric currents; the auricles, when pricked, and when excited by the electrical
ntracted very slightly, presenting the appearance, more nearly resembling a slight
an a well marked contraction. The voluntary muscles on the other hand responded
both mechanical and electrical stimuli.

iment 28: *Action of Hydrocyanic Acid on large Coluber Guttatus.—Linn.*

periment was performed in the month of June, and upon the same day with the
one.

ke was secured, and the heart exposed. Action of the heart 70 per minute. An
as made into the pericardium, and a few drops of a strong solution of Prussic Acid
the exterior surface of the heart. The effects of the poison upon the heart were
a few seconds, and in three minutes the action of the heart was reduced to 28 per

minute, and spasmodic contractions of the muscles were excited. At the end of this time a strong solution of chlorine in water was applied to the exterior surface of the heart, producing a much stronger and fuller action in the auricles and ventricles. The excitement of the chlorine, however, was only temporary, for in 12 minutes after the application of the Hydrocyanic Acid, and 9 minutes after the application of the chlorinated water the pulsations of the heart were 20 per minute. The heart continued to beat slowly, with diminishing frequency and power for one hour, and at the end of this time, *it could be aroused to action, neither by mechanical means nor by strong interrupted electrical currents. The voluntary muscles on the other hand, responded to the electrical excitement.*

It is worthy of note, that the chlorinated water excited the heart and increased its action, even whilst the organ was under the influence of Prussic Acid.

Experiment 29: Action of Hydrocyanic Acid on Emys Serrata.—Daudin.

This Chelonian had been kept for 12 months, abundantly supplied with water, but had been deprived of food. When the sternum was removed, all the structures were infiltrated with serous fluid, and the blood was very watery. This experiment was performed upon a warm day in June, and notwithstanding the heat, the reptile from its long fast was sluggish, and all its motions were exceedingly feeble. I have elsewhere presented the results of a series of experiments upon the effects of thirst and starvation upon reptiles, and we will not therefore dwell upon the physical and chemical changes of the solids and fluids in this Chelonian. The heart was flabby in its structures, slow and feeble in its actions, and the structures offered but slight proofs of excitement, when pricked with the point of the knife. The application of Prussic Acid to the heart was attended by much slower and less decided effects, than in the case of healthy well fed reptiles; the ultimate effects, however, were the same, the actions of the heart were rendered spasmodic and their synchronism destroyed, and the frequency gradually diminished until all action ceased. Spasms of the muscles were excited before death.

The heart in this case unlike the previous cases continued to beat, after the voluntary muscles had lost all irritability under the action of mechanical stimulants.

From these experiments we may, with reason conclude, that Hydrocyanic Acid exerts a specific influence upon the structures of the heart, independent altogether of its effects upon the cerebro-spinal nervous system. It might be objected, however, that in each case, and even where the poison was applied directly to the surface of the heart, it was absorbed and acted upon the heart only through the cerebro-spinal nervous system, from whence, according to some physiologists the heart derives all its powers. However plain the teachings of these experiments may be to our own mind, it is nevertheless important that we should, before proceeding further, consider the relations of the action of the heart in cold-blooded animals to the cerebro-spinal nervous system, and the sympathetic or organic system.

RELATIONS OF THE ACTION OF THE HEART IN COLD-BLOODED ANIMALS, TO THE CEREBRO-SPINAL AND SYMPATHETIC NERVOUS SYSTEMS.

The relations of the heart to the cerebro-spinal and sympathetic nervous systems, are highly complex, and their complete development would require an extended examination of the nature of muscular irritability and nervous excitation, and the relations of respiration, capillary circulation and the chemical composition and changes of the blood, to the heart's action; and we shall now present only such well established facts and experiments as will enable us to decide whether Hydrocyanic Acid acts directly or indirectly upon the heart.

The fact that the heart and the muscular system generally, would in cold-blooded animals, continue to act for a considerable length of time after the removal of the brain, has been known for more than two-thousand years. Aristotle alluded to the independence of the action of the heart and the motions of tortoises; and Pliny in his great work on Natural History, in the sixty-ninth Chapter of the eleventh book, not only states the fact that the heart is formed first among the viscera of the fœtus, and is followed by the formation of the brain and other organs, and last of all, by the eyes, but asserts that the heart is the last of all the organs to die. Pliny considered the heart as the principal seat of the heat of the body, the primary source and origin of life, and as containing within itself the primary receptacles for the spirit, and the blood in its sinous cavities,

mind also, he supposed had its abode; and affirmed that while all the other
injured, vitality may still remain in the heart. Redi found that tortoises
ere even able to walk for six months after he had completely removed their
arcot, Wepfer, Stalpart, Brinius, Morgagni, Haller, Brodie and others, have
counts of fœtuses without brains. Vesalius more than three centuries ago,
rtificial respiration, to protract life in animals whose breasts he had opened
to observe the motions of the heart, (*De humani corporis*, fabrica, Basileæ,
24;) and thereby demonstrated the dependence of the action of the heart
ation. Hook, in 1667, presented to the Philosophical Society of London,
nt of an Experiment of preserving animals alive by blowing into their lungs
rs," (Phil. Trans. 1667, No. 28, p. 539,) and confirmed the truth of the
of Vesalius. Haller in his great work, *Elementa Physiologie* and in his
ex Phisiologie, has given many examples of the action of the heart, after all
with the cerebro-spinal nervous system has been severed; and John Baptist
in the third volume, fifty-second letter, and twenty-seventh Chapter of his
The Seats and Causes of Diseases investigated by Anatomy," has given
s performed by himself, and has brought forward the examples of fœtuses
and delivered, not only without the cerebrum and cerebellum, but also
medulla oblongata and spinalis, which prove the independence of the action
t, of the cerebro-spinal nervous system. John Hunter (Proposals for the
persons apparently drowned, Phil. Trans., Vol. lxvi, read March, 1776:
ns on certain parts of the Animal Economy, 1786;) Edward Goodwyn
of Life with Respiration, etc.;) William Cruikshank, (Phil. Trans., Vol.
77,) and Sir Benjamin Brodie (Phil. Trans., 1809, p. 161, 1811, p. 36,
8,) confirmed the experiments of Vesalius and Hook, upon Artificial Respi-
rendered still more clear, not only the dependence of the heart's action
pply of arterial blood, but also its independence of the action of the cerebro-
ous system. Zavier Bichat has in like manner, recorded observations and
s, which prove the independent action of the heart. The fact that the heart
oded animals will act for some time after its removal from the body, is now
known and acknowledged, and I have witnessed this phenomenon in
xperiments, which I have performed, upon Fish, Batrachians, Amphiumas,
idians, Chelonians and Saurians.

ni from an extended series of experiments upon the circulation and respira-
-blooded animals, under various conditions, and in various stages of develop-
only confirmed the view of Lavoisier and others, that *oxygen* is essential to
and circulation, and in fact to all vital actions, but that the rapidity of the
f oxygen, is in proportion to the force and activity of animals: thus warm-
mals, absorb more oxygen and exhale more carbonic acid than cold-blooded
By numerous experiments he demonstrated that in cold-blooded animals, and
m-blooded animals as the bat, muscadine rat, and marmot, in proportion as
ture is lowered, the amount of oxygen absorbed, and of carbonic acid thrown
ively diminishes, and the pulsations of the heart and the respirations become
ngly feeble and less frequent, and when the absorption of oxygen ceases, the
f the heart and the respirations, also cease. Spallanzani concludes from his
xperiments, that the irritability, in consequence of which the heart contracts
g the exclusion of the blood which passes through it, essentially depends
mbination of the oxygen with this hollow muscle, and that when there is no
xygen, the pulsations cease. The oxygen gas absorbed by the pulmonary
ins access to the heart, and by entering into combination with that viscus,
ts muscular action in a state of excitement and life. Spallanzani also showed
ion of the heart, and the development of the red color, in the blood of the
whilst enclosed in the egg, is due to the chemical action of oxygen; and
the process of incubation is going forward the most essential use of the shell,
oxygen to the inert fœtus, by which means it becomes animated, has its

parts evolved, and gradually arrives at a state of maturity; and when on quitting the shell, it ceases in this way to receive its usual supply of the principle, it immediately receives it by the lungs, which the oxygen gas has put into motion. (Memoirs on Respiration, by Lazarus Spallanzani, edited from the unpublished manuscript of the author, by John Senebier, London, 1805.)

The experiments of Spallanzani, Sylvester, Humboldt and Provincal, on the influence of the air contained in water on the life of fishes; the experiments of Smith and Humboldt, showing the dependence of muscular action upon chemical change; the experiments of Hunter, Spallanzani, Mangili, Prunelle, and De Saissy and Edwards, upon the hibernation of the bat, hedgehog, marmot and dormouse; of Goodwin, Buffon, Le Gallois, Bichat and Edwards, upon asphyxia; the experiments of Crawford, Delaroche and Edwards, upon the amount of oxygen consumed, and of carbonic acid gas evolved at different temperatures; the experiments of Allen and Pepys, of Dulong, and of Edwards, upon the chemical changes of respiration; the experiments of Spallanzani, Vauquelin, Vogel, Brande, Sir E. Home and Edwards, showing the formation of carbonic acid in the blood and organs, and the extended series of experiments by Dr. W. F. Edwards, "On the Influence of Physical Agents on Life," all tend to establish the important law, that all motions in the animal economy depend ultimately upon the chemical changes of the structures.

From the results of an extended examination of the progressive development of the organs and tissues of animals, and of a series of experiments upon the chemical changes of the constituents of animals, I was led to the following conclusions with reference to the action of the heart:

1st. The forces which work the heart, like those which are active in every muscle, are developed by the chemical changes of the constituents of the heart and blood.

2d. The cerebro-spinal nervous system adds no force or actual motive power to the heart, although it may influence its action, through the ganglionic system proper of the heart, and through that portion of the vaso-motor system of nerves which regulates the supply of blood to the muscular structures of this organ.

3d. The automatic and rythmical actions of the heart are chiefly dependent upon a system of ganglia distributed through its muscular textures.

The cessation of the action of the heart after its separation from the cerebro-spinal nervous system and from the organs and general circulatory system, is due to many causes besides the mere deprivation of any nervous force supplied by the cerebro-spinal system, viz: the changes induced in the blood of its capillaries, and in its muscular fibres, the products of which changes are deleterious to the living tissues. In the living animal the blood supplying the heart is constantly purified from these products by special organs, as the liver, and kidneys, and lungs. If the chemical composition of the blood circulating through any organ be greatly changed, derangement and final cessation of the action of the organ must necessarily ensue. In the living animal, the integrity of the blood is constantly preserved by various organs; the liver forms the birthplace of its corpuscles, elaborates its crude compounds, supplies it with grape sugar and albumen, and removes various deleterious coloring matters and salts; the spleen exerts certain effects upon colored and colorless corpuscles; the kidneys continually remove from it such products of chemical change as urea, uric acid, the phosphates, sulphates, chlorides and extractive and coloring matters; and the lungs supply the great element of chemical change, oxygen, and at the same time eliminate the poisonous carbonic acid. If the heart be removed from the body, its actions will continue as long as the elements of chemical change are supplied in the proper portions, and until its muscular structures and ganglionic cells, and special system of nerves are poisoned by the chemical compounds resulting from its physical and chemical changes and actions.

However logical and true these conclusions may be, it is nevertheless important that they should be examined by the light of direct experiments upon the action of the cerebro-spinal nervous system upon the heart. We shall confine our attention chiefly to the experiments performed upon cold-blooded animals; the action of the heart in

ooded animals will receive further examination, as the phenomenon is more
ated in this class, notwithstanding that the principles which we have just
d,and the experiments which we are about to recount, apply also to the relations
ous and muscular of forces in all animals.

nzani performed numerous experiments upon frogs and salamanders, to deter-
relations of the circulation to the spinal marrow and brain. He found that
of the brain and spinal marrow was attended with violent convulsions of the
during these disturbances of the muscular system, the circulation in the capil-
uld not well be observed, but as soon as they subsided, the circulation was
be unimpeded and unchanged. Destruction of the brain and spinal marrow
ffect the circulation in any appreciable manner.—Experiences sur le Circula-
rage par J. Tourdes, Paris; Exp. cvi–cxviii.

a placed the source and principle of life, and of all animal motion, in irrita-
d contended that the circulation is independent of the brain and spinal marrow.
stains this view by the results of experiments upon the nervous circulatory and
ry systems, in which he affirms that irritation of the nerves supplying the
struction of the brain and spinal marrow in cold-blooded animals produced
an acceleration nor retardation of the action of the heart.—Traite sur
a, de la Vipere; Florence, 1771; Tom. I, pp. 81, 90, 93, 289; Tom. II,

Vhytt, after decollating a frog, destroyed its spinal marrow, by pushing a small
own through its spine, which occasioned strong convulsions of all the muscles,
y those of the inferior extremities. Ten minutes after this, the thorax was
and the heart found beating at the rate of 45 times a minute. Sixteen minutes
collation, it moved 40 times in a minute. After half an hour, it made 36, and
y minutes, only 30 pulsations in the minute, which were now also become very
d feeble. This observer, after decollating another frog, destroyed its spinal
with a red hot wire, which produced terrible convulsions in all the muscles, as
st experiment. Thirty-five minutes after the decollation and destruction of the
arrow, the thorax was opened and the heart observed, beating 30 times in a
One hour and fifty minutes after decollation, the heart made 20 pulsations in
e; three hours and twenty minutes, when the room was become warmer by the
of the sun, the heart beat 25 times in a minute, and when placed in the sun-
t performed 31 contractions in that time. After this the frog was removed to
window, where it was exposed to a cool breeze, upon which the motion of its
came slower, so that in a short time it made only 25 pulsations in a minute.
e anew to the sun-beams quickened its beat to 30 times in a minute. Six hours
een minutes after decollation and the destruction of the spinal marrow, the
of this frog's heart which were still filled with blood, contracted 12 times in a
but the ventricle lay without motion, was swelled and very red; however,
icked with a pin it performed two or three pulsations, and then remained at rest
ed by a new *stimulus.* Ten minutes after this observation, the ventricle seemed
ite dead, but the auricle continued its motion. Three hours after the ventricle
n without motion, the auricle which was very near as much filled with blood, as
e heart was first exposed, beat 11 or 12 times in the minute; its pulsations,
, were not so regular, as to time as they had been before. Dr. Whytt concluded
ese experiments, that an influx of fluid from the nerves into the muscles, and
y into the heart, is not necessary for their contraction. *Edinburg Physical*
vol. ii, pp. 282–285.

e Gallois, concluded from his experiments upon cold and warm blooded animals,
heart derives its power from all parts of the spinal cord without exception; but
riments upon frogs did not fully sustain this proposition, for although the sud-
ruction of the brain and spinal cord was followed by a temporary cessation in
n of the heart, the organ subsequently renewed its pulsations.

Dr. A. P. Wilson Philip,* concluded from his numerous experiments upon cold-blooded animals, that the power of the heart is independent of the brain and spinal marrow, for it continues to perform its function after they are destroyed or removed, and that their removal is not attended by any immediate effect on its motions. It may be urged with some degree of justice and force, against the series of experiments instituted by Dr. A. P Wilson Philip, to show that certain agents as solutions of Opium and Tobacco, and Spirit of wine, are capable of influencing the action of the heart when applied to any considerable portion of the brain and spinal marrow, that the effects upon the heart were due to the absorption of the agents by the blood-vessel system and their direct action through the blood upon the ganglia and muscular fibres of this organ. From his experiments upon warm and cold-blooded animals, Dr. Philip not only arrived at the conclusion of Haller, that the heart and other muscles possess an excitability independent of the nervous system, but was carried a step farther, and affirmed that they are all equally capable of being stimulated through this system; by which view he thought that the great objections to Haller's doctrine were removed.

Mr. William Clift, shortly after Dr. Philip's researches, performed similar experiments with similar results upon the carp. The heart was exposed, the effects of the destruction of various portions of the brain and spinal cord observed. Mr. Clift concluded, that: whether the heart is exposed or not, its action continues, long after the brain and spinal marrow are destroyed, and still longer when the brain is removed without injury to its substance. The action of the heart is accelerated for a few beats, by exposure of that organ; by exposure of the brain; injury to the brain; destruction of the spinal marrow while connected with the brain; by the connection between the brain and spinal marrow being cut off; while removing the whole brain, produces no sensible effect upon the heart's action, and destroying the spinal marrow after its separation from the brain renders the action of the heart slower for a few beats. Phil. Trans., 1815, pp. 91–96.

M. Flourens, from an extended series of experiments, arrived at the following conclusions:

The circulation does not depend immediately upon the Brain and Spinal Marrow; but its dependence, although not immediate, is none the less real. Thus in proportion as the nervous system is destroyed, the circulation becomes circumscribed and enfeebled; first the sub-cutaneous capillary circulation is extinguished, then that of the larger vessels, and finally, the circulation is confined to the heart and large trunks. The energy and duration of the circulation, depends therefore, upon the nervous system, for in proportion as the brain and spinal cord are destroyed, the circulation is enfeebled, and at the end of a certain time, after the destruction of the nervous system, the action of the heart and the circulation is entirely destroyed. In the second place, the circulation depends upon the power and existence of the nervous system, not only in a general and absolute manner, but in a special and determinate manner. For when any special region of the nervous system, is alone destroyed, it is always alone in those parts corresponding to the portion destroyed, that the circulation shows itself enfeebled. There is then a general influence exerted by the whole nervous system upon the entire circulation, and also local and partial influences of the different portions of the one, upon the different regions of the other. Finally, in all cases, the complete destruction of the nervous system, so enfeebles the entire circulation, that sometimes when the vascular circulation still survives, the sub-cutaneous capillary circulation is almost immediately stopped. This last point is worthy of attention, for it has led several others to regard the capillary circulation, either as independent of the general circulation, or on the other hand to be more exclusively subjected to the nervous action. The capillary circulation is neither more particular nor exclusively dependent upon nervous action than the general circulation; but it manifests soonest this action, because being placed at the periphery of the vascular circulation, it is most sensitive to impressions. But, however related, the nervous and circulatory systems may be, this relation is not instantaneous, because the former may be destroyed, and yet the latter continue for a certain time; neither is the relation immediate, because a particular connecting link is found in the Great Sympathetic. Du Système Nerveux, Paris, 1827. More recently, M. Flourens adopted the opinion that the circulation was more especially dependent upon that portion of the spinal marrow and medulla oblongata, which is essential to respiration, and endeavors to sustain his view by experiments, the results of which do not differ materially from those of Spallanzani, Whytt, Philip, Le Gallois and Cliff.

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Dr Marshall Hall repeated the experiments of these observers, with the following results:

The brain and spinal marrow of a frog were removed with the utmost precaution, to avoid the effect of shock. The circulation in the web, which had been most vigorous, was observed to become very gradually slower; it was lost in the capillaries in five minutes, in the veins in ten, and in the arteries in between fifteen and twenty. The whole of these changes were slow and progressive. Some intervals elapsed before the lung was examined, and its circulation had ceased. The heart still beat feebly thirty-six times in a minute. Scarcely any blood was lost. A flat stilet was introduced and passed through the brain and spinal marrow of another frog at various times, until the whole was destroyed, yet so slowly, that no shock was produced. The circulation in the web was at first nearly natural, but in a very short time it grew gradually slower and feebler, until it ceased. The movement in the blood in the arteries first became slow, and like that in the veins; then oscillation as when the heart is removed. The capillary circulation and that in the veins gradually ceased. There was still a degree of circulation in the large vessels, and even in one or two of the capillaries in the lungs, and this organ was moved by each contraction of the heart. The heart itself still beat vigorously and regularly forty-eight times in a minute. These experiments were repeated by Dr. Hall, upon another frog, and upon two eels, with similar results, and they led him to believe, that the action of the heart is enfeebled from the moment it is deprived at once of the influence of the brain and spinal marrow; and that the connexion of the heart with the nervous system, is precisely of the same nature as that of the voluntary muscles; both possess a degree of irritability independent of the large masses of the nervous system; both if separated from these masses, gradually lose their irritability: the irritability, therefore, is doubtless a faculty or property of the muscular fibre, yet it may become extinct without any obvious change in that fibre; its continuance or renewal, depends ultimately upon the masses of the nervous system. Dr. Hall believed that from the moment of the abstraction of the brain and spinal marrow, the irritability of the heart begins to fail; the circulation is first enfeebled, then lost in the most distant parts of the system, then in parts less remote; the distance to which it extends may aptly be taken as expressive of the remaining power of the heart, the principal organ of the circulation.

Dr. Marshall Hall endeavored to determine the effects of destroying the part of the medulla oblongata on which respiration depends, and of the entire brain and spinal marrow, by successive portions at distant intervals, and found that the destruction of the medulla oblongata did not arrest the circulation, as had been asserted by M. Flourens, and finally, that the frogs lived much longer, and the circulation continued much more active for a greater length of time, when the brain and spinal cord were removed by successive portions. In one instance the circulation continued, but little altered, for about forty hours after the entire destruction of the brain and spinal cord. A repetition of the experiments of applying various substances, as alcohol and infusion of opium and tobacco directly to the brain and spinal marrow, was attended with very different results from those announced by Dr. Wilson Philip: Dr. Hall found that alcohol and infusion of opium affect the circulation equally, whether they be applied to the brain and spinal marrow, or to the exterior of the body and extremities, and that after frogs were rendered insensible by immersing the extremities in laudanum, alcohol ap-

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Dr. Hall* does not attempt to determine the mode in which this sympathy is exerted, neither does he in any part of his experiments refer it to the sympathetic nervous system. If his experiments upon crushing the brain, and spinal cord, and the organs indicate anything of physiological importance, it is intimately associated with the action of the heart, arteries and capillaries. In crushing an organ, no matter how remote from the central organ of circulation, we crush the bloodvessels of the organs destroyed; now, as these blood-vessels are surrounded with the fibres of the sympathetic or vaso-motor nerves, which form a chain of communication with the sympathetic ganglia and nerves of the heart, it is but reasonable to suppose that their destruction should exert an effect upon the general circulation.

Bidder removed with great care the arches of the second cervical vertebra, so that little blood was lost during the operation, and then completely destroyed the spinal cord.† Frogs treated in this way, often lived six weeks, sometimes ten weeks, the circulation, as seen in the web of the foot, remaining at the same time active, and not differing from that in uninjured frogs. The heart beat powerfully and quickly; in a freshly killed frog, in winter, the heart pulsated thirty-five times in the minute; while in a frog, the spinal cord of which had been destroyed twenty-six days previously, the pulsations were forty per minute. When the brain and spinal cord were destroyed, the medulla oblongata being left, frogs were retained in life until the sixth day; and when the entire central organs of the nervous system were removed, they lived until the second day; the rapidly ensuing death in the latter case being due, according to Volkmann, to the effects produced upon the respiration. Within a few weeks after the destruction of the spinal marrow, the muscles of animal life were found to have lost their irritability in a marked degree, and still later, no contraction could be produced in them by application of chemical or mechanical stimuli; the heart, however, in such cases, still continued to pulsate eleven times in the minute, and retained its property of responding to external stimuli. The intestinal canal, in like manner, retained its irritability; application of stimuli giving rise to contractions which were sometimes of a local nature, at other times extended for a considerable distance on either side of the part stimulated. Digestion, in like manner, suffers but little from destruction of the central parts of the nervous system; healthy frogs, and others which had been operated upon, were, after being starved for a considerable time, fed with worms, and kept in separate glasses. In the one as well as in the other, the worms were found after twenty-four hours to be fully digested, and the stomach and duodenum were filled with colored mucus; such was observed to be the case even in animals whose spinal cord had been destroyed twenty-six days previously. The secretion of urine also continues; when, in animals in which the brain or spinal cord had been removed, the bladder was emptied by external pressure upon the walls of the abdomen, in a short time it again became filled and distended to an enormous size, unless emptied in the way just mentioned. It had been observed by Valentin and Stilling, that after destruction of the spinal cord in the frog different derangements in the nutritive process ensued; there were frequently observed dropsical swellings, especially of the limbs. On these also sores formed, which often penetrated as far as the bones. In reference to these results, Volkmann states that they are, as shown by Bidder, chiefly accidental. Bidder found that when the bottom of the vessels in which the frogs were kept was covered, not with water, but with moist grass or moss, no such derangements ensued.

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* A Critical and Experimental Essay on the Circulation of the Blood, Especially as Observed in the Minute and Capillary Vessels of the Batrachia and of Fishes. Phil., 1835, pp. 92-125.

† Cyclopædia of Anatomy and Physiology, Part xlvii. Aug. 1855, pp. 457-458.

The rapid death which ensued in warm-blooded animals, when operated upon in the above manner, depends, according to Volkmann, upon the difficulty of sufficiently keeping up respiration by artificial means, as well as upon the loss of blood and diminution of animal heat. The circumstance, then, that a certain number of the vital phenomena disappear suddenly and irrecoverably after destruction of the spinal cord and brain, while others continue for a greater or shorter time, and this very perfectly, can only depend, according to Volkmann, upon the circumstance that the brain and spinal cord is a necessary condition for the existence of the former, but not of the latter. If the latter depend upon certain nervous organs, and if the nerves of the sympathetic or vegetative organs do not require, as a fundamental condition of their activity, the presence of the brain and spinal cord, the only possible centres on which they can depend for this, are the ganglia of the sympathetic.

The sympathetic and its ganglia, therefore, according to Volkmann, constitute an independent whole, from which proceed the impulses to, as well as the regulation of, those actions which continue after the brain and spinal cord have been destroyed, and which notwithstanding, require the co-operation of a central organ. That the movements in question, require such an organ, and are not produced by the mere stimulus of the blood, fæces, air, etc., in the same way as the twitchings of the muscles of a frog's leg are produced by galvanism, is shown according to Volkmann, by the different characters exhibited by the two. When stimulus acts immediately on motor nerve fibres contraction ensues only in that muscle, or part of the muscle, to which these are distributed; when it affects the whole trunk of such a nerve, many muscles are excited to contraction; the contraction so produced, however, is a mere quivering, quite different from the combined and plan-like movements of the muscles of respiration, etc., or those reflex movements which are produced artificially. In these there is a certain unity and plan, in the others not; the difference depending on the circumstance that in the one a regulating principle associates the muscular movements for the attainment of an organic act or purpose; in the others this does not take place. When the regular and plan-like manner in which the pulsations of a heart removed from the body take place, is compared with the tumultuous and purposeless quiverings of a diaphragm similarly circumstanced, it is hardly possible to suppose that the two kinds of movement proceed from the same principle. Irritability acted on by the stimulus of the blood or air, might explain the mere contraction of the heart; the regular order however, in which this takes place, implies the existence of a regulating principle; and a regulating principle implies the existence of a regulating apparatus. While the regular movements of the voluntary muscles suddenly cease when the brain and spinal cord are destroyed, those of the organic muscles continue; and hence their regulating apparatus cannot lie in the brain and spinal cord, and can only therefore be situated in the ganglia of the sympathetic.

We have thus endeavored to examine the various experiments of Physiologists illustrating the relations of the action of the heart to the cerebro-spinal and sympathetic nervous system, and this research has only still farther strengthened the conclusion that certain poisons, as Hydrocyanic Acid, may act directly upon the muscular and nervous structures of the heart, and thus arrest its movements without any intervention of the cerebro-spinal nervous system.

We propose, however, still farther to illustrate this proposition by the following:

EXPERIMENTS ILLUSTRATING THE DIRECT ACTION OF PRUSSIC ACID, CYANIDE OF POTASSIUM AND STRYCHNIA, UPON THE HEART OF COLD-BLOODED ANIMALS, WHEN REMOVED FROM ALL CONNECTION AND COMMUNICATION WITH THE CEREBRO-SPINAL NERVOUS SYSTEM.

Experiment 30: preliminary on a fine active corn snake (Coluber Guttatus—Linnæus,) in the month of June, illustrating the effects of removing the heart entirely from the influence of the cerebro-spinal nervous system.

The heart of this snake was exposed, and after the excitement induced by the operation had subsided, the action of the heart was 76 per minute.

The trachea and œsophagus were severed just below the head, opposite the cervical vertebra, and all the viscera (lungs, heart, liver, spleen, pancreas, intestines and kidneys,) removed, and the cloaca secured just below the junction of the ureters. Previous to, and during the operation ligatures were applied, so as to retain the blood, both in the blood-vessels of the trunk and of the viscera. After the removal of the viscera, and whilst the lungs were completely collapsed, the heart beat only 30 times to the minute. The action of the heart commenced to diminish in frequency during the removal of the viscera, owing to the complete expulsion of air from the lungs at the moment that the wind-pipe was secured. The whole operation occupied 10 minutes, so that in 10 minutes the heart had lost 46 beats per minute. The lungs were then inflated so as to imitate the respiration of the snake; in a few moments the action of the heart was increased, both in frequency and force, and soon rose to 76 per minute. The movements of the heart appeared as usual to the naked eye, and felt as usual when the fingers were placed around the organ and gently pressed against it.

The heart continued to beat for two hours, although the lung had been allowed to collapse. One hour after the entire removal of the heart and viscera out of the body, from all connection with the cerebro-spinal nervous system, notwithstanding the collapsed state of the lung, the heart was beating regularly 16 times per minute, and presented both a natural appearance and regular normal actions.

Experiment 31; Illustrating the Action of Hydrocyanic Acid upon the Heart removed entirely from the Cerebro-Spinal Nervous System of a large, active King Snake (Coronella Getula—Linnæus,) 6 feet in length, in the month of June.

The heart was exposed, its pulsations per minute were 66; the viscera were then removed, and at the end of the operation the action of the heart was 52 per minute. The pericardium was opened, and a solution of Prussic Acid applied upon the external surface of the heart.

In two minutes, the action of the heart fell to 28 per minute, notwithstanding, that the respiration in the lung was kept up, after the removal of the viscera by artificial means. In 4 minutes the action of the heart was 18 per minute; the contractions and expansions of the auricles and ventricles were spasmodic and irregular; and the shape of the heart changed, presenting a flaccid, relaxed appearance. When the heart was pressed between the fingers, it felt perfectly relaxed, and a most marked difference from its full strong resisting feeling, before the application of the Prussic Acid. Six minutes after the application of the poison, action of the heart 14 per minute, very feeble and weak, both to the sight and to the touch, and its color both in the auricles and in the ventricles, had deepened to a dark purplish black and blue color.

Eight minutes after the application of the Prussic Acid, the ventricles of the heart presented a peculiar tetanized appearance, the muscles are drawn together and firmly contracted into knots, and all action in the muscles have ceased, notwithstanding that artificial respiration has been maintained throughout the whole time. The auricles although more relaxed have ceased to beat, and cannot be aroused, either by mechanical means or by strong interrupted electrical currents.

On the other hand the heart of the snake, which had been removed with the viscera, one hour before this, was still beating 16 times per minute, although the lungs had been allowed to collapse completely for one hour—its structure was dense, well colored and firm, and its contractions vigorous.

The trunks of both these snakes from which the viscera had been removed, continued to respond and to execute certain motions, as coiling and striking when irritated for more than one hour; and the muscles were capable of being excited to contraction and movement by mechanical and electrical stimuli, for more than three hours after the removal of the viscera.

It might have been said that in the previous experiments, the action of the Prussic Acid was reflex; that is, through the cerebro-spinal system of nerves, but the two preceding experiments 30 and 31, demonstrate conclusively that Prussic Acid acts directly upon the heart, independent altogether of any influence through the cerebro-spinal nervous system.

In order to settle this important question definitely, the following experiments were instituted with Prussic Acid and other poisons:

Experiment 32: Effects of Hydrocyanic Acid on the Heart of the King Snake, (Coronella Getula). April 6th, 1861.

A solution of Prussic Acid was prepared extemporaneously, by dissolving forty grains of Cyanide of Potassium and forty grains of Tartaric Acid in four fluidounces of water.

The heart of the King Snake (Coronella Getula) was exposed, and its pulsations numbered 80 per minute; it was then severed from its vascular attachments, and dropped immediately in a glass vessel containing the solution of Hydrocyanic Acid. In three-fourths of a minute its pulsations were 60 per minute; three minutes after its introduction into the poisonous solution the auricles ceased to beat, and there was only a spasmodic motion of the ventricle, which was contracted and contorted in various ways, as if the muscular fibres were tetanized; in three and a half minutes, one-half minute after the last observation, the motions of the ventricle were very feeble, and the tissues of the heart began to loose the contracted, tetanized appearance, and finally became flabby and relaxed. The flabby state was characteristic alike of the auricles and ventricle.

Half a minute after the last observation, and four minutes after the commencement of the experiment, every sign of motion and vitality had disappeared from the heart.

The snake continued to contract and contort itself; and to move about, and strike, when irritated, after the removal of the heart; and after the expiration of twenty minutes, the solution of Prussic Acid was poured down its throat, and into the cavity from which the heart had been removed. The effect of the poison was to produce contractions, contortions and increased motions at first, and then in the course of fifteen minutes all motion ceased.

Experiment 33: Preliminary Experiment on the action of Pure Water on the Heart of the Yellow-Belly Terrapin, (Emys Serrata).

The sternum of a large, female Emys Serrata, (Yellow-Belly Terrapin), was removed April 6th, 1861, at 4½ o'clock P. M., at Montevideo, (residence of my father, Rev. C. C. Jones, D. D.), in the Southern part of Georgia. The weather was warm and pleasant, and the terrapin, which had been recently captured in the swamp, was active and vigorous.

Action of the heart before removal from its attachments, 16 per minute. In the month of April, on the coast of Georgia, in the swamps and rice fields, the circulation is rather sluggish in cold-blooded animals, being diminished in frequency during the cool nights, and increased by the heat of the sun in midday.

The heart of the terrapin was then cut out without injury to its muscular substance, the large arteries and veins being severed about two-tenths of an inch above their junction with the heart.

The heart was immediately thrown into fresh spring water, (upon analysis I found the water to be very pure; it issued from a sand bed).

Three and a half minutes after the introduction of the heart into the spring water, its pulsations were 15 per minute, and were strong and regular; 11 minutes after, action of heart accelerated, 22 per minute and regular; 30 minutes after, heart beating 10 times per minute, actions regular; 65 minutes after, heart still beating with regularity and force, 4 times per minute; 90 minutes after its introduction into the water, heart still beating slowly, three times per minute.

Throughout this experiment, the tissues of the heart appeared natural, and presented a striking contrast to the contracted tissues of the heart placed in Hydrocyanic Acid.

Experiment 34; Effects of Prussic Acid on action of Heart of large Emys Serrata, (Yellow-Belly Terrapin).

Heart of fine, large, female Emys Serrata severed from the body and thrown into solution of Hydrocyanic Acid of the same strength and temperature as that employed in experiment 32. Montevideo, April 6th, 1861, 4:47 o'clock P. M.

Heart beating 16 times per minute before being introduced into the Hydrocyanic Acid. The immediate effect of the Hydrocyanic Acid, was to increase the action of the heart from 16 per minute to 62 per minute, during the first minute after its introduction; after the lapse of the first minute, however, the action of the heart fell to 22 per minute, and the fibres were unequally contracted, and the muscular walls presented a rough, unnatural, corrugated, appearance.

In ten minutes the heart presents a livid and wrinkled appearance, and the ventricle merely trembles 12 times per minute. The entire shape of the ventricle is altered; it presents a wrinkled, contracted, contorted appearance.

The heart of the terrapin immersed in the spring water, on the other hand, just before this experiment, looks perfectly natural, and is beating 14 times per minute.

Seventeen minutes after being placed in the solution of Hydrocyanic Acid, there is nothing observable about the heart, save a slight tremulous motion, which is not excited by mechanical stimuli. The tissues of the heart are also becoming more relaxed. 24 minutes after being placed in the Hydrocyanic Acid, all signs of life are extinct in the heart, whilst the heart which has been in pure spring water for 30 minutes, still beats 10 times per minute, regularly.

Experiment 35; Repetition of Experiment 33; Effects of pure water on action of Heart of Emys Serrata (Yellow-Belly Terrapin.)

Sternum of male Emys Serrata, removed: heart beating regularly 16 times per minute; heart cut out and thrown into pure spring water; the contact of the water excited increased action and it rose in 7 minutes from 16 to 48 beats per minute; 13 minutes after, pulsations of heart 40 per minute, regular and good; 27 minutes after commencement of experiment, action of heart 24 per minute; 43 minutes after, still beating slowly and regularly.

Experiment 36: Repetition of Experiment 34; Effects of Prussic Acid on Heart of active male Emys Serrata, April 6th, 5.15 o'clock, P. M., 1861

This active, male Emys Serrata, appeared to be in a perfect rage during the removal of the sternum, struggling and biting furiously; the action of the heart appeared to have been increased by these exertions, and the organ beat 50 times per minute. Heart removed and thrown immediately into solution of Hydrocyanic Acid of similar strength to that used in Experiment 34.

The first effect of the Hydrocyanic Acid was to increase the action of the heart several beats, from 50 to 56 per minute.

Three minutes after introduction into Hydrocyanic Acid, action of heart 24 per minute and spasmodic; (action of heart placed in water, 10 minutes before (*Experiment* 35,) 40 per minute and regular;) 6 minutes afterwards, action of heart 14 per minute; surface of heart presents a wrinkled, contorted appearance; 15 minutes after immersion in the poisonous liquid, the auricles ceased to act, whilst the ventricle beat very feebly 10 times per minute, whilst the heart in the pure water was beating regularly and strongly 24 times per minute; in 25 minutes, all motion in the heart immersed in Hydrocyanic Acid, had ceased.

Experiment 37: Effects of solution of Cyanide of Potassium, on action of Heart of Young Opossum, (Didelphis Virginiana.) Montevideo, Ga., April, 1861.

The young opossum was taken out of the *pouch* of its mother; and at the time of its removal it was sucking vigorously at the teat of its mother. The thorax was opened and the heart cut out, and dropped into a solution of Cyanide of Potassium, of the strength of 10 grains, dissolved in one fluidounce of water. After falling into the solution the heart beat rapidly, for a few moments, and then ceased in one minute, after its first introduction, and could not be excited to any farther action.

Experiment 38: Effects of solution of Cyanide of Potassium on action of Heart of Pided Viper, (Heterodon Platirhinos)

Heart cut out and thrown into solution of Cyanide of Potassium, 10 grains to fluidounce of water.

Action of heart, after being cut out and before being thrown into the solution of Cyanide of Potassium, 48 per minute. After its immersion in the solution of Cyanide of Potassium, in one quarter of a minute its beat had fallen to 40 per minute, and in half a minute, the ventricle and auricles contracted spasmodically, and the ventricle was corrugated, as if portions of the muscular fibres were more contracted than others. In three minutes, all action in the heart had ceased entirely, and it could not be excited to contraction even by mechanical stimuli.

Experiment 39; Effects of solution of Cyanide of Potassium on action of Heart of female Emys Serrata.

Montevideo, Ga., April, 1861. Sternum of large female Emys Serrata removed, and heart exposed; action of heart before being cut out, 70 per minute; after it was severed and removed from the body, 64 per minute. Immediately after throwing the heart into the solution of Cyanide of Potassium, 10 grains to fluidounce, the action was slightly increased from 64 to 70 beats per minute. In half a minute, however, its action began to decline in frequency, and in 3 minutes it beat 40 times per minute. The effect of the poison was very marked in destroying the symmetry of the actions of the heart.

The heart in its natural state, in Chelonians beats thus: the auricles contract, and then the ventricle in regular order. The Cyanide of Potassium destroyed this relation of the action of the auricles and ventricles; under its poisonous influence the two auricles could be seen contracting separately; the auricles and ventricle simultaneously; and one auricle and the common ventricle simultaneously. After this irregular action had been established for a few moments, the muscular bundles of the ventricle then became corrugated, and irregularly contracted. Nine minutes after placing the heart in the solution of Cyanide of Potassium, it beats 36 times per minute, the ventricle spasmodically, with contortion of the muscular fibres; whilst the auricles give but little indication of any action whatever; 15 minutes after immersion in solution of Cyanide of Potassium, action of heart 21, spasmodic and wholly unlike the natural action; in 20 minutes, all signs of action had ceased, the ventricle still presenting a corrugated, contorted outline, with a very slight spasmodic twitching in a few of the fibres; a few moments after this, all signs of motion ceased.

In the preceding experiment (39,) the poison (Cyanide of Potassium,) appeared to act upon the sympathetic ganglia of the heart, as well as upon the muscular fibres, dissociating their mutual and rythmical impulses; and the rapidity of its action appeared to be universally proportioned to the amount of muscular fibre and number of ganglia.

Experiment 40; Effects of a solution of Strychnia on Heart of Alligator, April, 1861.

Sternum of Alligator Mississippiensis, 2½ feet in length, opened, and heart exposed; action of heart after exposure and before removal 60 per minute. The heart was then cut out and thrown immediately into a solution of Strychnia, of the strength of 20 grains of Strychnia and 20 grains of Citric Acid, dissolved in four fluidounces of water.

The action of the heart became slower and slower, as soon as it was immersed in the solution of Strychnia, and ceased altogether in three minutes after its immersion, and presented a corrugated wrinkled appearance.

The effects of the Strychnia, were even more rapid than those of the Cyanide of Potassium.

Experiment 41; Effects of Strychnia on Emys Serrata.

Sternum of yellow-belly terrapin (Emys Serrata), removed, heart cut out and thrown immediately into solution of Strychnia, (Strychnia, grs., xx; Citric Acid, grs., xx; Water, fluidounces, iv); the first and immediate effect appeared to increase the rapidity of the action of the heart, and the force also appeared to be increased, and the actions to be rendered more spasmodic: in three minutes, the surface of both the auricles and ventricles, presented a corrugated appearance; the auricles acting with as much apparent energy as the ventricle; six minutes afterwards, the auricles contracted spasmodically thirty times per minute, whilst the ventricle contracted fully only once or twice per minute; in 13 minutes all signs of action had ceased, and the ventricles and auricles presented a corrugated appearance.

Experiment 42: Action of Prussic Acid on Heart of Emys Reticulata, April, 1861.

Sternum of Emys Reticulata (Chicken Terrapin) removed; heart exposed. Action of heart, 34 per minute. Applied solution of Prussic Acid, (Cyanide of Potassium, grains, xl, Tartaric Acid, grains, xl, water, fluidounces, iv); in two minutes the action of the heart was reduced to 12 per minute, and became spasmodic, exhibiting violent contortions of the muscular fibres.

The muscular system of the terrapin also appeared to be affected within two minutes after the application of the poison as manifested by several spasmodic movements of the limbs. The auricles are greatly distended with blood, as if the muscular fibres had been paralyzed by the action of the poison. Five minutes after the application, the action of the heart is becoming more rapid, and is now 22 per minute; 33 minutes after application of poison, action of heart very spasmodic and irregular, 12 per minute; 38 minutes, 5 minutes after last observation, action of heart very feeble and spasmodic; muscles of body respond readily to mechanical stimuli; 53 minutes, action of heart very feeble and spasmodic, 12 per minute, mucles of limbs strongly spasmed; 86 minutes, action of heart 14, the ventricle contracts feebly and spasmodically, whilst the auricles are distended with black blood, and contract scarcely at all as far as can be seen by the naked eye.

The terrapin still elongates the head and thrusts out the limbs. When the heart is simply exposed, and allowed to remain undisturbed in its natural position, and the poison is applied directly to its structures, the action is not so rapid as in the former experiments, when the heart is cut out entirely and plunged into the solution, because it is supplied with blood, which is constantly renewed, and the absorbed portions of the poison mingle with the entire mass of blood, and thus the immediate action on the structures of the heart is modified and weakened.

Experiment 43; Effects of Prussic Acid on action of Heart of Emys Serrata Yellow-Belly Terrapin. April, 1861.

Sternum of large Emys Terrapin (female) removed; action of heart 36 per minute. The pericardium was opened, and the Prussic Acid solution dropped upon the muscular surface of the heart; the effects were visible in 20 seconds—the motions became spasmodic, and in 30 seconds the heart beat very spasmodically, and in one minute it ceased to beat and remained quiet for one minute, when pricked it renewed its action, and then stopped for half a minute, and again commenced its action, and 5 minutes after the application its beat was 32 per minute, and spasmodic, the surface presenting a corrugated appearance. Ten minutes after the first application a few more drops were poured in; one minute after this second application, the action of the heart was 32 per minute. At this point, the general muscular system showed the effects of the poison, and several spasmodic motions were given; 48 minutes, action of heart 20 per minute, and spasmodic; 101 minutes, action of heart 18 per minute, and spasmodic. The voluntary muscles are still active, the terrapin stretches out his neck and endeavours to breathe, with a spasmodic motion of the throat. Twelve hours after, action of heart 9 per minute; 18 hours after first application of poison, action of heart 9 per minute; muscles of heart and limbs still continue to contract; 24 hours, (6 hours after last observation) all motions in the voluntary muscles have ceased, but the heart still acts 9 times per minute. All voluntary and reflex muscular movements have ceased, and cannot be excited by stimuli.

In the preceding experiment (43), we see that the action of the heart continued longer under the action of Prussic Acid, than the excitability of the voluntary muscles. The results of this experiment seem to indicate, that Prussic Acid acts with more violence upon the cerebro-spinal nervous system than upon the sympathetic.

Experiment 44: Effects of Prussic Acid on Alligator Cooter, (Chelonura Serpentina).

Poured a quantity of the Prussic Acid solution down the throat of a powerful and fierce Alligator Cooter, which was about 12 inches in diameter across the carapace. Although the poisonous dose was twice repeated in the course of one hour and a half, no appreciable effect was manifest, and the animal remained active and powerful, and appeared to be well 24 hours after the experiment. From this experiment we gather, that certain animals are less susceptible than others to the action of Prussic Acid, and also that the effects are more marked when the poison is applied directly to the structures of the heart.

Experiment 45; Effect of Strychnia on the heart of Musk Cooter (Sternothærus Odoratus.)

Sternum of active Musk Cooter removed; heart cut out and thrown immediately into a solution of Strychnia (Strychnia, grains 10; Citric Acid, grains 10; water fluidounces iv); pulsations of heart after severance from the body, and before immersion in solution of strychnia 22 per minute. During the first minute, after immersion in the solution of strychnia, the pulsations of the heart increased to 40 per minute; then subsided during the second minute to 30; during the third minute the motions became feeble and spasmodic, and at the end of the third minute ceased altogether.

Experiment 46; Effects of direct application of Solution, of Strychnia to the surface of the Heart of Emys Serrata.

Sternum of large Emys Serrata removed, and heart exposed; strong solution of strychnia (grains 10 in fluidounce of water, with sufficient Citric Acid,) applied to surface of heart in situ; in 7 minutes tetanic spasms of voluntary muscles action of heart spasmodic and slight, 16 times per minute. In 40 minutes all action in the heart had ceased, with the exception of a very slight occasional spasm of the muscular fibres of the ventricle. No motion could be perceived in the auricles, which were greatly distended with blood. The voluntary muscles were still occasionally spasmed, but the force of the tetanic spasms had greatly diminished.

Experiment 47; Effects of the direct application of a solution of Strychnia to the surface of the Heart of Chicken Terrapin Emys Reticulata.

Exposed the heart of a large female Emys Reticulata, by removal of the sternum; action of heart 48 per minute; applied strong solution of strychnia to heart. The effects of the strychnia in altering the motions of the heart, were visible almost immediately; violent spasms of the voluntary muscles at a later period, in three minutes. One minute after the application of the strychnia, the action of the heart had been diminished near one-third, in two minutes one-half, and in three minutes it ceased suddenly and completely, and the organ presented a wrinkled, contracted appearance, as if its fibres were thrown into tetanic spasms.

Experiment 48; Repetition of preceding Experiment, (47).

Strychnia solution applied to heart of Emys Serrata; results similar, with the exception, that the heart did not cease to beat quite so rapidly as in the preceding experiment.

Experiment 49: Effects of Ligating the Large Blood-Vessels of the Heart, and severing the organ from the body.

The heart of the common toad was exposed, and a ligature thrown around the large blood-vessels, and secured so as to enclose the blood. Action of the heart, before the application of the ligature around its blood-vessels, 60 per minute. In less than one minute after the application of the ligature, the heart ceased to beat; and simultaneously with, or rather just preceding this change, the color of the blood in the cavities of the heart changed to the venous hue, a dark, purplish black. It is easy to distinguish the color of the blood in th cavities of the heart of the toad, on account of the thinness of the walls. The heart ce beat, because it was paralyzed by the retention of carbonic acid. When cut out and into pure, fresh, spring water, after a few moments it commenced its pulsations ag renewal of its action appeared to be due, not merely to the stimulant action of th also to the absorption and removal of the carbonic acid gas by the surrou

Experiments 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60; Repetitions of the preceding experiments.

On the direct action of Prussic Acid, Cyanide of Potassium and Strychnia, on the hearts of various cold-blooded animals; results similar to those previously recorded.

Experiments 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79 and 80:

Illustrating the effects of the direct application of the mineral acids (Nitric, Hydrochloric and Sulphuric), and of such astringents as Alum, Sulphate of Iron and Sulphate of Copper, to the hearts of cold-blooded animals.

The effects of these agents varied with the degree of concentration; when concentrated, they coagulated the blood, acted chemically upon the structures of the heart, and rapidly arrested its action; when, however, properly diluted, they, especially in the case of Hydrochloric Acid and Sulphate of Copper, exerted a much less decided effect than Hydrocyanic Acid, Cyanide of Potassium and Strychnia, and, in fact, in some instances appeared to act as stimulants.

It is a matter of interest, in a practical point of view, to determine whether there is any substance which will exert a direct stimulant effect upon the heart, and thus be capable of counteracting the effects of such poisons as Prussic Acid and Cyanide of Potassium upon the central organ of circulation. The element which first suggested itself to my mind, was Chlorine.

EXPERIMENTS ILLUSTRATING THE EFFECTS OF CHLORINE.

Experiment 81: Illustrating the Action of Chlorine.

A small, active Congo Snake (Amphiuma Means), 10 inches in length, was chosen as the subject of this experiment, which was performed in the month of June, 1862. The weather was warm and the animal was active. The Amphiuma was immersed in a solution of Chlorine in pure water. The effects of the Chlorine were immediate and powerful, producing the most rapid and continuous motions.

Experiment 82: Illustrating Effects of Prussic Acid.

Another Amphiuma, immersed in a solution of Prussic Acid, presented the peculiar effects of this poison as already described, and was rapidly rendered insensible, and finally destroyed.

Experiment 83; Effects of Cyanide of Potassium.

A Siren Lacertina, immersed in a solution of Cyanide of Potassium, still farther illustrated the difference of action between Prussic Acid and Cyanide of Potassium, on the one hand, and of Chlorine on the other.

Experiment 84; Action of Strychnia.

The action of the Chlorine was still farther compared with that of the action of Strychnia upon a large Siren Lacertina.

The muscular motions excited by the Strychnia, were of a spasmodic and violent character, and the body of the Siren was frequently quite rigid, and the muscles irregularly contracted; whilst the motions on the other hand, excited by the Chlorine, were rapid, easy and unattended by any spasm or rigidity of the muscles, and the animal appeared rather to be excited and exhilerated by the Chlorine.

The preceding experiments, 81, 82, 83 and 84, were performed in large glass vessels, so that all the varied motions and effects induced by these agents, viz: Chlorine, Hydrocyanic Acid, Cyanide of Potassium and Strychnia, could be carefully noted and compared.

In the experiment with Chlorine (81), in a few moments the surface of the body of the Amphiuma Means became viscid, and was covered with a whitish, abundant, mucous secretion, presenting an appearance of partial coagulation. The whitish mucus was detached from the body in long shreds. The Chlorine acted in this case upon the mucous membrane of the skin in the same manner that I have often seen it act upon the mucous membrane of the mouth and bronchial tubes of warm-blooded animals, exciting a flow of mucus. After presenting these lively and vigorous vibrations for one hour, they gradually decreased in number and vigor; the forces were gradually exhausted, and in the course of one more hour all signs of life were extinct. Before life was extinct, and subsequent to the secretion of mucus, considerable endomose (absorption) of the chlorinated water had taken place, and the whole body of the Amphiuma Means was distended. The heart was exposed several minutes after all signs of movement had ceased, and after it was impossible to excite movements by either mechanical or electrical stimuli; the heart was still acting regularly and with force nearly equal to that of health. Strong, interrupted electro-magnetic and galvano-electric currents produced but very slight perceptible contractions of the muscles, whilst the heart still continued to beat regularly and with considerable force. Half an hour after the exposure of the heart, it was beating regularly 34 times to the minute, and continued to beat for more than two hours.

Experiment 85: Action of Chlorine on Heart of Chicken Snake. June, 1862.

The serpent was properly confined upon its back, and the heart laid bare; and after the excitement induced by the preparation and operation appeared to have passed, the heart pulsated 72 times per minute. The pericardium was punctured, and the surrounding space filled with a strong solution of Chlorine in water.

The contact of the chlorinated water with the exterior surface of the heart was followed by an almost immediate increase both in the force and rapidity of the action of the heart; in two minutes it pulsated 75 times per minute.

The heart was kept exposed for four hours; during this time the chlorinated water was applied to the exterior surface several times, at intervals of about one hour; the Chlorine would invariably increase its force and frequency, and especially the power of its movements. When the Chlorine was withheld, the excitement of the heart gradually subsided.

At the end of five hours, the serpent was loosed, and appeared as strong and as lively as ever. The next day, 24 hours after the application of the chlorinated water, the chicken snake appeared to be as well and as active as ever. The heart was beating regularly 62 times per minute. The exterior of the heart, with the exception of a blackened appearance, presented nothing unusual; there were no marks of inflammation.

Chlorinated water was then injected directly into the cavities of the heart until they were distended with it; the effects upon the blood were immediate and well marked, changing its color to a dirty, reddish brown; and simultaneously with this change of the blood, the heart ceased to beat, and could not be excited to action even by strong magneto-electric and electro-magnetic currents.

The reptile, however, continued to move about for some time after the cessation of the action of the heart, and even attempted to strike.

In this experiment, the almost immediate cessation of the action of the heart, when the Chlorine was injected into its cavities, appeared to have been due to the almost total abstraction of blood, (the blood having been driven entirely out of the blood-vessels, and even out of the capillaries of the heart, by the action of the Chlorine upon the sympathetic ganglia and cardiac and vascular muscular fibres), and to the complete chemical alteration of the small quantity of blood which remained in the capillaries of the heart.

Small quantities of Chlorine, on the other hand, if they be too small to produce any marked chemical changes upon the elements of the blood, which are indispensable to the nutrition and proper action of the muscles, act as a stimulant to the muscular fibres.

We have before shown that Chlorine will arouse the heart, even when under the direct action of Prussic Acid, increasing both the number and force of its actions.

We are justified in concluding, therefore, from these experiments, that Chlorine exerts a direct stimulant effect upon the heart, and in virtue of this stimulant effect is capable of counteracting, to a certain extent, the effects of Prussic Acid.

the colored blood corpuscles presented altered appearances, assuming stellate form change however in the colored corpuscles is not characteristic of the action of Prussic as I have seen it in the blood of healthy cats as well as in the blood of animals destroy various poisons.

This experiment was performed in winter, and the blood remained without any sig putrefaction, for several days.

One hour and a half after death, the muscles responded feebly to the action of the i rupted electric current. The blood-vessels of the brain were filled with dark blood. Ca microscopical examination failed to detect any characteristic alterations in the brain, sp marrow or sympathetic system, which could be referred to the action of the poison.

Lungs not congested with blood, except in the dependent portions.

Blood-vessels upon the exterior of the stomach and intestines engorged with blood; mu surface not specially discolored. Blood-vessels of liver filled with dark blood.

Experiment 115: Repetition of preceding Experiments on several Cats. Prussic Ac administered by the Mouth and by Sub-cutaneous Injections.

The results corresponded in the main, with those just detailed; no uniform effects we observed after death in the cerebro-spinal or sympathetic systems, which could be referred t the action of the poison. The blood-vessels of the alimentary canal, were uniformly congested with blood. Both the external and internal surfaces of the intestines were exami immediately after death; presented a normal color without any discoloration from the col ing matter of the blood corpuscles. If the examination was delayed for many hours, the the intestines and stomach presented a reddened appearance as if the poison had produced an intense inflammation accompanied by an effusion of the altered coloring matter of the blood into the surrounding tissues.

These changes were clearly referable to causes acting after death.

In the majority of cases, the blood-vessels of the liver were filled with dark blood; th condition however was not uniform. Whenever the poison entered the stomach, it produc a reddish, inflamed appearance of the mucous membrane, and the lips and tongue, with wh the poison came in contact, changed also to a more brilliant red during life.

Experiments 116, 117, 118, 119, 120, 121, 122, 123, 124, 125: Repetition of preceding Experiments with Prussic Acid upon various warm-blooded animals—(Ca Dogs, Rats, Rabbits, Guinea Pigs, etc.) with similar results.

The points which we wished especially to establish at this stage of the inquiry, wer

1st. Does Prussic Acid exert any special effect upon the action of the heart in the Mammalia?

2d. Is there any other poison which is capable of arresting the action of the heart?

3d. If Prussic Acid arrests the action of the heart, is there any agent, or remedy capable of counteracting the direct action of Prussic Acid on the heart.

We have before demonstrated that Prussic Acid acts directly on the heart in col blooded animals, independently altogether, of any influence transmitted through the cerebro-spinal nervous system; and that Chlorine acts as a stimulant to the heart an tends to counteract the action of the Prussic Acid on the heart, and also that Chlor acts as a stimulant to the cerebro-spinal and sympathetic nervous and muscular syste and in virtue of this action also tends to counteract the action of Prussic Acid.

The ends of the present inquiry, therefore, are similar to those of the previous experiments upon cold-blooded animals.

In attempting to determine whether Hydrocyanic Acid exerts any special and dir effect upon the action of the heart in warm-blooded animals, it was necessary, as in the case of the cold-blooded animals, to determine first, the relations of the heart to the cerebro-spinal nervous system. It is a matter of importance to determine whether the sudden destruction of the brain and spinal-marrow in warm-blooded animals will exe any effect upon the action of the heart. If Hydrocyanic Acid suddenly arrests the functions of the brain and spinal cord, and, if the action of the heart is at the sa time arrested, it is highly important to determine which was affected first? wheth one was affected and not the other; whether the death of the brain and spinal-marrow was caused by the death of the heart; or whether the death of the heart was caused by quick, communicating to the fingers which grasp it, a strong resistance, and sharp spasmodic feeling.

The effects of Strychnine upon the muscular fibre of the heart appear to be similar to those upon the muscles generally.

In poisoning by Prussic Acid on the other hand, the heart feels flaccid, when pressed beneath the fingers. The ventricle, especially, partakes of this relaxed flaccid condition.

In poisoning by Prussic Acid, the auricles appear to act longer than the ventricle, whilst in poisoning by Strychnine the ventricle appears to act longer than the auricles.

Ten minutes after the application of the Strychnine, the voluntary muscles of the serpent are strongly and permanently tetanized, and in eighteen minutes, the heart ceased its pulsations entirely, and could not be aroused by interrupted magneto-electric and galvano-electric currents, which also excited little or no effect upon the voluntary muscles.

These experiments confirm those previously recorded, and show that Strychnia, as well as Prussic Acid, is capable of arresting the action of the heart.

Experiment 90: Action of Cyanide of Potassium on Congo Snake (Amphiuma Means), June, 1862.

This reptile was immersed in a solution of Cyanide of Potassium, 6 grains to ½ pint of water; no special effects were observed for 3 hours; at the end of this time, the muscular system was thrown into violent spasms, and the muscles of the throat appeared to be permanently tetanized At the end of six hours, all signs of life were extinct. When the heart was exposed, it was found to be perfectly motionless, and could not be aroused, either by mechanical or electrical stimuli. The voluntary muscles on the other hand, responded vigorously and readily to the interrupted magneto-electric current, *thus showing that although the powers of the heart were destroyed, still the voluntary muscles retained their power of responding to stimuli.*

The intestinal canal was congested with blood, and the abdominal cavity contained effused blood, which coagulated, upon exposure to the atmosphere.

Under the microscope, the blood corpuscles from the blood of the heart presented in many cases perfect forms, whilst in some cases they presented an elongated spindle-shaped appearance, instead of the usual oval form

These experiments therefore confirm those previously recorded, and clearly establish the important physiological and therapeutic principle, that whilst two poisons may both act upon the cerebro-spinal and sympathetic systems, and upon the muscular fibres of the heart, they may do so in different modes and in different degrees, and that an antidote which is applicable to one, may have no value in poisoning by the other.

We endeavored to determine whether Prussic Acid exerted a greater effect over one portion of the cerebro-spinal nervous system, than over the remaining parts; and to define as far as possible the nature of the action, and whether it was direct and immediate upon the ganglionic cells of the cerebro-spinal axis.

The following series of experiments were devised for the solution of these questions:

EXPERIMENTS ILLUSTRATING THE DIRECT ACTION OF HYDROCYANIC ACID ON THE MEDULLA OBLONGATA.

The following ten experiments were performed in the month of April, 1862, at Montevideo, Liberty, Co., Georgia:

A solution of Prussic acid was freshly prepared, of a strength equal to that of the fresh Acidum Hydrocyanicum Dilutum, U. S. P.

For these experiments I selected ten young alligators (Alligator Mississippiensis) of the same age, and from the same nest.

Effects of Prussic Acid administered by the Mouth. *Experiment* 91.—Poured a solution of Prussic acid, in amount about f℥ss., down the mouth and throat of a small young alligator. The reptile was only six inches in length, and had not left the eggshell more than a week or ten days.

In three and a half minutes the alligator manifested signs of the action of the poison, in its staggering gait and convulsive movements; in twelve minutes, gaping and struggling violently, with spasmodic movements of the muscles; in fifteen minutes, breathes only occasionally (once every two or three minutes), and then in a spasmodic manner, lies indifferently upon the back and belly, and cannot walk; sixteen minutes after the first application of the poison, and one minute after the last observation, all motions appear to have ceased; when thrown into cold water, however, it appears to be aroused by the shock, and makes several attempts to swim and turn on its side; these motions ceased in a few minutes, and when turned over on its back in the water, it remained so, whilst an alligator whose cerebrum had been exposed, and touched with the same solution of Prussic acid, remained vigorous and strong.

Twenty-six minutes (ten minutes after the preceding observation), lies as if dead, without any motion, except, every two or three minutes, a spasmodic, feeble, respiratory effort; mechanical stimuli produced but a slight tremulous motion of the muscles, whilst irritation of the muscles of the alligator whose cerebrum had been exposed and treated with Hydrocyanic acid, induced vigorous respiratory motions; in thirty minutes (four minutes after the last observation), all external signs of life have vanished, and the animal appears to be dead.

Thirty minutes after the application of the poison, the thorax was opened and the heart exposed; auricles and ventricles greatly distended with blood, beating slowly and spasmodically forty times per minute; fifty-two minutes (twenty-two minutes after the last observation), action of heart twenty-six per minute; one hundred and twelve minutes (sixty minutes after the last observation), action of heart twenty-six per minute; one hundred and eighty minutes (sixty-eight minutes after the last observation), no signs of life in the muscular system; mechanical stimuli fail to produce contractions; heart still acts in a slow, spasmodic manner; the blood presents a brownish, purplish color; auricles and ventricle still engorged with dark blood; action of heart, twenty per minute.

Two hundred and fifty-eight minutes (seventy-eight minutes after the last observation), pulsations of the heart still continue, they are, however, slower and more irregular and spasmodic, the *rhythm* of its action has been destroyed; the auricles act continuously about ten times per minute, the ventricle not so often. The action of the heart continued to grow slower and slower until it finally ceased. The exact time was not noted.

Prussic Acid applied to Brain of Alligator. Experiment 92: Removed the superior plate of the cranium of a small alligator (six inches in length), and exposed the superior surface of the cerebrum without wounding the large veins and arteries. The membranes were carefully removed from both hemispheres, so as not to injure the great central vessels running between the hemispheres and the cerebellum.

The surface thus exposed was moistened with the solution of Prussic acid.

Four minutes after the direct application of the poison to the surface of the cerebrum, no signs of the action of the Hydrocyanic acid; the surface of the brain was wounded, and the poison again applied. In eleven minutes (seven minutes after the last observation), the effects are beginning to become manifest, in a decrease of activity and life in the muscular motions: the reptile is still able to crawl about, and to make the sounds usually emitted by young alligators. The blood oozing from the wounded surface of the brain presents a brilliant crimson color.

In fifteen minutes (four minutes after the last observation,) motions spasmodic, gasps for breath, and emits quick, spasmodic sounds, like an imperfect bark; these spasmodic motions ceased in a few moments. The reptile crawled off and attempted to bite the finger when placed before its head, and when thrown into cold water it swam rapidly. The effects of the poison appear to be due chiefly to its absorption by the blood-vessels of the brain, and its distribution to other portions of the nervous system, and not to a direct action upon the nervous structures constituting the cerebrum.

The poison was again applied to the exposed surface of the cerebrum, and its structures were again injured so that the poison might come in immediate contact with the nervous elements. Twenty-four minutes after the first application, still able to swim, but evidently losing power: the respiration is slow, spasmodic and irregular. In the last application, the nervous structures were more extensively injured, and the poison more effectually applied.

The forces gradually declined, and thirty-six minutes after the first application (twelve minutes after the last observation,) the alligator has so far lost voluntary motion that, when thrown into cold water it remains indifferently upon the back or belly, as it may be placed; still breathing, but the respiration is very slow and spasmodic.

The heart was next exposed; the act of cutting through the muscles to expose the heart caused contractions of the various parts of the thorax and fore-limbs; action of heart thirty-eight per minute, more regular and active than the heart of the alligator in the preceding experiment, auricles and ventricle filled with crimson blood; forty-two minutes, action of heart thirty-eight.

One hundred and sixty-eight minutes after first application of poison to cerebrum (one hundred and twenty-six minutes after last observation), the reptile has greatly recovered, and is attempting to walk; heart beating with considerable regularity and force.

The remaining coverings of the superior and posterior parts of the cerebrum, especially those portions of the dura-mater and arachnoid which dip down between the hemispheres, and between the cerebrum and cerebellum, were removed. Considerable hæmorrhage ensued from the large blood-vessels; this was wiped carefully away, and the Prussic acid again which possess organs of generation. Hunter regarded the heart as a truly mechanical engine:

> "For although muscles are the powers in an animal, yet these powers are themselves often converted into a machine, of which the heart is a strong instance; for, from the disposition of its muscular fibres, tendons, ligaments and valves, it is adapted to mechanical purposes, and this construction makes it a complete organ or machine in itself."—Treatise on the Blood and Inflammation, 1793.

Xavier Bichat, in his work on "Life and Death," 1799, held that no direct influence is exercised by the brain over the heart, which, on the contrary, is immediately dependent, with regard to its operations, on the movement communicated to it by the blood. Bichat attempted to sustain this proposition by the facts, that: 1st, all violent irritation of the brain produces either partial or general convulsion in the muscles of animal life, but no such effect upon the muscles of organic life; 2d, all compression of the cerebral mass has ordinarily the effect of paralyzing the voluntary muscles, but so long as the affection does not extend to the respiratory muscles, the action of the heart is in no degree diminished; 3d, Opium and Wine, when taken in a certain quantity, diminish the cerebral energy, and render the brain unfit for the functions of the animal life, the action of the heart, on the contrary is increased; 4th, in palpitation and the different irregular movements of the heart, it is not observable that the principle of these derangements exists in the brain; 5th, the numerous phenomena of apoplexy and epilepsy, concussion, etc., do all of them certainly tend to show how independent the heart is of the brain; 6th, every organ which is subject to the direct influence of the brain, is, for that very reason, an organ of volition; the heart, on the contrary, is not subject to the volition. Bichat endeavored to establish the independence of the actions of the heart from those of the cerebro-spinal system, by the following experiments:

> 1st. If the brain of an animal be exposed and irritated, either with mechanical or chemical agents, a variety of alterations will indeed be produced in the organs of the animal life, but none in the heart so long as the muscles of the breast continue to perform their functions.
>
> 2d. Experiments made in the same manner upon the spinal marrow of the neck, present the same results.
>
> If the eighth pair of nerves be irritated, the movements of the heart will not be accelerated; they will not be arrested if these two nerves be divided. In all these experiments, however, we must be careful to make a proper distinction between the emotions and passions of the animal, and what it really suffers from the experiment.
>
> 4th. The nature of the great sympathetic nerve is supposed to be known; now, if the same experiments be made on the cardiac branches of the nerve, as were made upon the eighth pair, the same results will follow.

Sir B. C. Brodie, in the series of experiments which he instituted, to ascertain how far the influence of the brain is necessary to the action of the heart, found that when an animal was pithed, by dividing the spinal marrow in the upper part of the neck, respiration was immediately destroyed, but the heart still continued to contract, circulating dark colored blood, and in some instances, from ten to fifteen minutes elapsed before its action had entirely ceased; when the head was removed, the divided blood-vessels being secured by a ligature, the circulation still continued, apparently unaffected by the entire separation of the brain; when artificial respiration was instituted in the beheaded animals, the heart continued in some instances to contract for two hours, with apparently as much strength and frequency as in a living animal. From these experiments, Sir Benjamin Brodie concluded, that "The influence of the brain is not necessary to the action of the heart; and that when the brain is injured or removed, the action of the heart ceases only because respiration is under its influence, and if, under these circumstances, respiration is artificially produced, the circulation will still continue."—Phil. Trans., 1811, pp. 36–48.

Sir Benjamin Brodie, from his experiments upon the action of Alcohol, concluded that the symptoms produced by a large quantity of spirits taken into the stomach, are entirely from disturbance of the function of the brain; the complete insensibility to external impressions; the dilatation of the pupil of the eye, and the loss of motion indicate that the functions of this organ are suspended; respiration, which is under its influence, is ill-performed, and at last altogether ceases; while the heart, to the action of which the brain is not directly necessary, continues to contract, circulating dark colored blood for some time afterwards. His experiments upon the action upon living animals of the essential oil of Almonds, the juice of the leaves of Aconite, of the Upas Antiar, the oil of Tobacco, Arsenic, Muriate of Barytes, Tartar Emetic and Woorara in like manner convinced him that poisons might act directly upon the cerebro-spinal system, destroying all its functions, without interfering with the actions of the heart; whilst, on the other hand, poisons may act upon the heart, causing death from such action, without specially acting upon the cerebro-spinal nervous system.—Phil. Trans., 1811, pp. 178–208; Phil. Trans., 1812, pp. 205–227.

We have already considered, in the first chapter of the Medical Memoirs and in the present chapter, the experiments of LeGallois, and endeavored to show that they not only established the fact that the spinal cord is the especial seat of the reflex actions, but also that the continuance of the action of the heart after decapitation and the destruction of the spinal cord, is dependent rather upon the respiration than upon any nervous influence transmitted from the cerebro-spinal ganglionic centres.

The correctness of this view is sustained by the remarkable experiment, in which Le Gallois maintained the action of the heart and "life," for upwards of three-quarters of an hour, in the detached and isolated breast of a rabbit thirty days old. In this experiment, the belly of the animal was first opened, a ligature passed around the aorta immediately below the Cœliac trunk, another was passed around the vena-cava near the liver: a simple knot was tied in each of these ligatures. This being done, the trachea and both carotids were laid bare; each of these arteries were tied conjointly with the external and internal jugular veins; the trachea opened for the inflation of the lungs; the spinal marrow was then divided with a needle, near the occiput, and artificial respiration instituted, without waiting until the asphyxia had extinguished sensation; after it had been continued for three or four minutes, the animal being fully alive, the trachea is separated forward from the larynx, then the head is cut off at the first vertebræ of the neck, with a pair of scissors; and immediately resuming the inflation which is to be continued for three or four minutes, after which the knots are to be tightened, which had been previously prepared upon the aorta and the inferior vena cava; the inflation is then to be renewed, and again interrupted, at the end of three or four minutes, to cut off the hind parts, which is performed by taking away the intestinal tube from the beginning of the duodenum, then by dividing with scissors the soft parts surrounding the vertebral column, and then the column itself, immediately below the ligatures made on the aorta and the vena-cava. In this manner, there remains only the breast, the stomach and the liver, which might also be removed if care be taken to prevent hæmorrhage. The operation being finished, all that remains is to continue inflation of the lungs, as long as the breast has any signs of life. The most apparent of these signs, are the motions and the sensations preserved in the fore feet, and the small writhing motions observed in the thorax, when the skin is severely pinched, and when the posterior extremity of the dorsal portion of the medulla spinalis is touched. In some cases after carrying the experiment thus far, the remainder of the cervical portion of the medulla spinalis and part of the dorsal were destroyed, and although life existed only in the two posterior thirds of the breast it could still be prolonged. *Experiments on the Principle of Life, etc.*

Dr. A. P. Wilson Philip, whose experiments upon cold-blooded animals we have already considered, also examined the relations of the heart to the cerebro-spinal nervous system, and demonstrated the independence of the action of the heart by such experiments as the following:

system generally, and especially to the respiratory system, are the first phenomena manifested in the action of Prussic Acid.

When absorbed from a raw surface, or from the stomach and bowels, these phenomena are manifested, as well as upon the direct application of the poison to the medulla oblongata, but more slowly. In warm-blooded animals death takes place almost immediately after the administration or inhalation of the poison; still, when taken by the mouth, a sufficient time always elapses for the absorption of the poison and its distribution to the great nervous centres. As soon as the poison in the blood reaches the medulla oblongata and spinal cord, convulsive motions are excited, and if the impression be sufficiently intense there is an immediate arrest of the action of the ganglionic cells presiding over the respiratory process, and immediate death follows.

In the young alligator the cartilaginous walls of the cerebro-spinal nervous system can readily be removed by the knife, and we are thus enabled to apply the poison to successive portions of the nervous system, and thus demonstrate the immediate and direct action of the poison upon that portion of the cerebro-spinal nervous system which presides over respiration and the reflex actions.

Prussic Acid, as we have satisfactorily demonstrated by numerous experiments, acts also on the blood, and on the muscular fibres and the sympathetic nervous system; but, as has been conclusively demonstrated by the experiments just recorded, the most marked phenomena, and those disturbances of the respiration which induce death, are due to the direct action of the poison on the medulla oblongata.

EXPERIMENTS ILLUSTRATING THE ACTION OF PRUSSIC ACID ON BIRDS.

Experiment 101. Several drops of officinal Prussic Acid were placed in the mouth of a large, active pigeon, in the month of January, 1860. The effects of the poison were manifest in 10 seconds; trembling of all the muscles; puffing up of the feathers; irregular action of the heart, and insensibility, and finally death in 75 seconds after the application of the poison.

Effects of the poison upon the Animal Temperature: Temperature of the atmosphere, 13°.3 C., 56° F. Temperature of rectum of pigeon, 40° C., 104° F.

The temperature remained stationary during the action of the poison, and then commenced to descend immediately after death, and stood at 32° C., 89°.6 F., one hour and five minutes after death.

Loss of temperature during 65 minutes after death, 8° C., 14°.4 F.; loss of temperature each minute after death, 0°.123 C., 0°.221 F.

Post-mortem Examination, 30 minutes after death. Hæmorrhage had taken place from all those portions of the mucous membrane of the mouth and throat, with which the poison had come in contact. The vapor of the Prussic Acid had also acted locally upon the skin, around the mouth, and upon the neck and chest; in those regions the skin presented a highly congested appearance, and in spots the blood appeared to have been locally effused. Blood-vessels of brain and spinal cord, not specially congested with blood. Muscles presented a darker color than usual in healthy birds. Blood of heart and blood-vessels generally dark, purplish, almost black; but changed to the arterial hue upon exposure to the atmosphere, and coagulated readily. Veins of intestines and liver distended with blood.

Experiments 102, 103, 104, 105.

Repetitions of preceding Experiment, (101) on the action of Prussic Acid on birds, results similar to those just recorded.

Experiment 106: to determine whether any agent acts rapidly as a stimulant to the Heart and Nervous System in Birds. Action of Chlorine on Pigeons.

The Chlorine was administered by inhalation. After the first inhalation, the effect of the Chlorine was immediate and well marked, quickly increasing the action of the heart, both in force and frequency, exciting violent struggles, and causing a rapid rise in the temperature, which in 5 minutes rose from 41°.9 C., 107°.4 F. to 42°.5 C., 108°.5 F.

The inhalation of the gas occupied only a few seconds, the mouth of the bird, was simply held over the mouth of the receiver containing the gas. After the removal, the temperature of the body continued to rise for 5 minutes, then remained stationary, and finally commenced to descend until it reached the same degree before the experiment. The action of the heart fell in force and frequency, with the fall of the temperature. The bird was again subjected to the action of the Chlorine Gas—as soon as it was inhaled, the action of the heart which had subsided with the fall of the temperature, immediately increased with renewed force and the temperature commenced also to rise, and in 2 minutes rose from 41°.9 C., 107°.4 F., to 42°.2

Cardiacus," as being formed by communicating branches of the *Eighth Pair*, and *Intercostal* or *Great Sympathetic Nerve*. According to this eminent anatomist,

> "The Plexus Cardiacus, is formed above the lung, on the fore side of the Bronchia, it produces a great number of filaments; some of which go to the Pericardium, and the rest through it, round the great vessels to be distributed to the heart."

Winslow states that while some of the filaments from the cardiac plexus, run over the trunks of the great blood-vessels, and over the auricles and ventricles of the heart, other and the chief filaments run in the cellular substance behind the aorta, between that and the trunk of the pulmonary artery, and after being divided into great many small nerves, which run before and behind the aorta, are distributed to the base and auricles of the heart. In Winslow's description of the mode of action and uses of the heart, he makes no reference to the nerves distributed to its substance.

William Cheselden, in his Anatomy of the Human Body, gives no description of the nerves of the heart; he appeared however to be aware of their relations to its actions, from the ingenious attempt to account for the systole and diastole of the heart and the reciprocal actions of the auricles and ventricles, which he quotes from Dr. Munro. *Anatomy of the Human Body*; ix Ed., London, 1768, pp. 197, 199.

B. J. Behrends (a pupil of Soemmering,) who whilst admitting in his *Dissertatio qua demonstratur Cor Nervis Carrere, 1792*, that nerves accompany the Coronary Arteries distinctly asserted that the muscular structure is entirely destitute of nerves.

Scarpa, clearly delineated and described nerves running on the heart independent of, and distinct from the Coronary Arteries, and in his elaborate work (*Tabulæ Neurologicæ*, 1794,) has given fine views of the nerves of the human heart, in some of which, upwards of twenty filaments may be counted on the same transverse line, to the base of the heart, together with numerous anastomotic angular enlargements, which Scarpa does not specify as ganglions in his text. In the hearts of the large herbivorous Mammalia, however, Scarpa describes and delineates both ganglia and fusiform enlargements of the nerves, which he called corpora olivaria, and these not only upon the nerves at the base of the heart, but upon those that are spread over the superficies of the ventricle. Scarpa also describes and figures several nerves independent of, and not accompanying the blood-vessels of the heart, and avails himself of the fact to refute the conclusions to which Behrends had arrived.

In Mr. Swan's splendid plates, the nerves are represented as accompanying the Coronary Arteries, and but few are distributed to the muscular tissue, and M. Chassaigne who translated in 1838, Mr. Swan's "Demonstration of the Nerves of the Human Body," denies that any nerves besides those which accompany the Coronary Arteries have ever been discovered in the heart.

Mr. Robert Lee, in an important paper published in the *Philosophical Transactions of the Royal Society*, 1849, pp. 43, 47, has demonstrated by careful directions and drawings, that the nerves and ganglia of the heart are far more numerous than those described and delineated by Scarpa. The series of dissections performed by Mr. Lee show that the nerves of the heart which are distributed over its surface and through its walls to the lining membrane and columnæ carneæ, enlarge with the natural growth of the heart, before birth, and during childhood and youth, until the heart has attained its full size in the adult, that the nervous supply of the left ventricle is greater than that of the right; and that when the walls of the auricles and ventricles are affected with hypertrophy, the ganglia and nerves of the heart are enlarged, like those of the gravid Uterus. In one of the dissections of the heart, on the anterior surface, there were distinctly visible to the naked eye, ninety ganglia or ganglionic enlargements on the nerves which pass obliquely across the arteries and the muscular fibres of the ventricles from their base to the apex. These ganglionic enlargements are observed on the nerves, not only where they cross the arteries, but where they ramify on the muscular substance, without the blood-vessels. On the posterior surface, the principal branches

The temperature of the rectum remained stationary for ten minutes after the administration of the poison, and then slowly descended, and at the moment when the heart and respiration ceased, it was 37°.5 C., 90°.5 F: thus, during the last twenty-six minutes of life, the temperature fell 1°.3 C., 2°.35 F. After death the temperature of the rectum continued to descend, and in twenty-eight minutes, stood at 36° C., 96°.8 F.; loss of temperature during twenty-eight minutes following death, 1°.5 C., 2°.7 F.: loss of temperature each minute after the action of the poison, up to the moment of death, 0°.05 C., 0.0903° F.; loss of heat each minute after death, 0.0535° C., 0.0964° F.

Post-mortem Examination: Thirty minutes after death, blood-vessels of the dura-mater, arachoid membrane, pia-mater and brain filled with dark, purplish, black blood. Blood-vessels of the membranes of the spinal-cord in like manner, filled with dark blood. Cerebro-spinal fluid abundant. The blood-vessels of the base of the brain, and of the membranes covering this portion of the brain, and the blood-vessels of the membranes and structures of the anterior portion of the spinal cord were more distended with blood, than the superior, and less dependent portion of these respective structures. This difference in the distribution of the blood, was without doubt due to the effects of gravitation.

The structures of the brain and spinal cord appeared to be altered neither in appearance nor consistency. There was a tendency, in some parts, to the exudation of blood through the walls of the blood-vessels; this tendency was not, however, so marked, neither were the vessels of the brain and its membranes so congested with blood as in a case of poisoning by Cyanide of Potassium, which will be subsequently recorded.

The blood of the brain and spinal cord, although presenting a dark, venous hue when the structures were first exposed, rapidly, after the removal of the skull-cap and membranes, absorbed oxygen, and changed to the arterial hue; this change was first evident in the minute ramifications of the vessels. The muscles of the body, on the other hand, did not appear to be as full of blood as in dogs killed by mechanical means.

Lungs not congested, but normal in appearance. The auricles and the right ventricle of the heart, the pulmonary arteries and veins, the vena-cava, and all the large venous trunks were distended with dark blood. The right auricle and ventricle of the head were distended to their utmost capacity with dark, almost black blood. The aorta and the arteries of all parts, contained no blood, and the capillaries of the muscles appeared to be almost entirely devoid of blood.

Strong, electro-magnetic and magneto-electric currents (interrupted) failed to excite any contraction in the fibres of the heart, whilst the muscles of locomotion and volition generally responded to the electrical excitement.

The veins of the stomach and intestines, even in their minutest ramifications, were distended with black blood. The mucous membrane of the stomach was, in some portions, congested with blood, and there were several dark purplish spots more strongly congested. The stomach contained matters in process of digestion, and this fact may account for a portion at least of the increase of color.

The mucous membrane of the small intestines presented a normal, healthy appearance, and was not congested. The portal vein was distended to its utmost capacity with black blood. The liver was congested with blood, and presented a very dark purplish color, from the engorgement of its portal and hepatic system of veins with dark purple, almost black blood. When cut, the dark blood streamed from the surfaces. The kidneys presented a dark slate purplish, almost black color, and when cut, the blood, in like manner streamed from those organs.

Whilst the veins of the spleen were filled with blood, there was no especial enlargement of the organ, neither was any blood effused into the cells of the spleen, as in malarial fever. When drawn from the vessels after death, the blood coagulated in less than one minute. The coagulum was soft, and there was a tendency in the colored blood corpuscles to separate from the fibrin, and to fall to the bottom of the vessel, and thus color the serum.

Under the microscope, many of the colored blood-corpuscles presented stellate forms. Cadaveric rigidity had not taken place two hours after death.

In the preceding experiment (111), the congestion was venous. The accumulation of the blood in the large venous trunks appears to be due to several causes, as the loss of power in the muscular structures of the heart, and especially in the right ventricle and right and left auricles, and the spasmodic tetanic contractions of the muscles.

The appearance of congestion in the veins of the brain, spinal cord and membranes, was due to the same causes which produced venous congestion in the liver, stomach and organs, it being evident that the venous congestion was not confined to any organ, or any special portion of the nervous system, it would, therefore, be unwise to refer the death of the animal to the congestion of the cerebro-spinal nervous system. Death appeared to have been caused by the action of the poison upon the ganglionic cells of the cerebro-spinal and sympathetic system, and especially upon the potential elements of the medulla oblongata, and of those ganglia regulating the vaso-motor system of nerves and the rythmical action of the heart.

Experiment 112: Action of Prussic Acid on powerful and fierce Bull Dog.

A strong solution of Prussic Acid was placed upon the eyes, lips and nose of a powerful bull dog. In a few minutes the dog struggled violently, acted as if in a great rage, attempted to rush at those around, his tongue appeared to become rapidly of a brilliant scarlet and presented a swollen appearance; then succeeded piercing cries, and violent spasms and finally death in five minutes after the first application of the poison.

Post-mortem examination 17 hours after death: Cadaveric rigidity well marked.

The blood-vessels of the brain and its membranes were not congested with blood. Spinal cord examined throughout its entire length; structures and blood-vessels normal in appearance; neither the vessels of the cord nor of its membranes presented any unusual congestion. Careful comparisons were instituted with the colored drawings, previously executed of the nervous structures and organs of various animals destroyed by mechanical means and by various poisons.

A careful and laborious examination was made with the microscope, of the structures of the cerebro-spinal and sympathetic nervous systems; but no alterations were revealed which could be referred to the special action of the poison.

The lungs were congested; the right lung was more congested than the left, and presented a dark, purplish slate color. The right lung also presented some spots of marked congestion which appeared of a deep purple color.

The cavities of the heart contained dark coagula of blood. When the uncoagulated blood was removed from the cavities of the heart it coagulated into a firm clot, and absorbed oxygen, and changed upon the surface to a bright arterial hue.

The right auricle and ventricle of the heart contained long, slender, white worms, several inches in length, which resembled in all respests the worms from the cavities of the hearts of dogs, which I presented in 1855 to Dr. Joseph Leidy, Professor of Anatomy in the University of Pennsylvania, and described by him in the Journal of the Academy of Natural Sciences. Several of these worms extended from the heart into the pulmonary artery. These parasites had been killed by the Prussic Acid.

When the abdominal cavity was opened, a most disgusting and overpowering gas issued, having an odor of Prussic Acid and Sulphuretted Hydrogen. I have observed similar gases in the abdominal cavity of dogs poisoned with Cyanide of Potassium, as well as with Prussic Acid.

The blood vessels of the small and large intestines and stomach were distended with dark blood, and the whole exterior surface of the stomach and intestines presented a dark red and purple color, as if the coloring matter of the blood had escaped from the vessels and penetrated the structures. The peritoneum was colored in a similar manner. Both the peritoneum and lungs contained deposits of melanotic matter. The mucous membrane of the stomach and intestines presented a reddish, purplish color. Liver and kidneys greatly congested with blood. The blood corpuscles did not present any changes of sufficent importance to be noted.

Experiment 113: Action of Prussic Acid on a large, male Hound Dog.

This dog, although active and endowed with a ravenous appetite, was lean, and could not be fattened even by the most generous diet. This dog also emitted an unpleasant smell, characteristic of that of dogs, suffering with worms in the cavities of the heart. I have found worms in the hearts of several dogs, who presented similar symptoms, and emitted similar odors; and in the present case, I was led to predict the presence of worms in the heart before death.

An incision was made into the skin of the hind leg, in the region of the knee, and about two fluiddrachms of a strong solution of Hydrocyanic Acid were injected into the subcutaneous cellular tissue. After the removal of the nozzle of the syringe, a considerable portion of the solution of Prussic Acid poured out. About one to two drops of the Anhydrous Acid (that is an amount of the solution corresponding to this quantity) were retained.

The dog was standing when the poison was injected; in one minute there were evident signs of its action; in two minutes there was trembling and twitching of all the muscles, spasms, then inability to stand up, and in a few moments more, loud howling followed by piteous whining; during the trembling twitchings and spasms of the muscles, the thermometer in the rectum rose 0°.05 C. The spasms and howling and whining, were succeeded by minutes by profound coma; 15 minutes after the injection of the poison, the dog still lies in a profound coma, respiration labored (inspirations very full, thorax dilated to its utmost in a spasmodic manner, expiration violent, forcing out almost all the air; and attended by a peculiar spasmodic motion of the diaphragm and abdominal muscles, giving a flattened appearance to the abdomen, and only two per minute; pulsations of heart 120 to 160 per minute, quick and spasmodic; action of large arteries beating with a quick spasmodic motion, as if they would leap out of the surrounding flesh. The temperature remains stationary.

One minute after the close of this observation, and 16 minutes after the injection of the poison the heart ceased to beat, the respiration having ceased a short time, about 20 seconds previous to the cessation of the action of the heart. If we date the death of this dog, at the moment of the cessation of the action of the heart, then the poison destroyed life in 16 minutes.

Effects on the Temperature. Temperature of atmosphere 21° C., 69.8° F.; temperature of rectum 39°.5 C., 103°.1 F. During the spasmodic struggle of the dog, there was a slight rise in the temperature of the rectum amounting to 0°.05 C. At the moment of death the thermometer indicated 39°.55 C. 103°.2 F. During the last ten minutes of life the thermometer remained stationary. The thermometer in the rectum remained stationary for 15 minutes, after the cessation of the action of the heart, moment of death; and in 20 minutes, 35 after death, indicated 38°.75 C. 101°.8 F. Temperature of rectum 70 minutes after death, 35 minutes after last observation, 37° C. 98.6; 130 minutes after death, 34°.9 C., 94°.8 F.; 140 minutes after death, 34.66° C., 94°.4 F.; 240 minutes after death, 31°.8 C., 89°.3 F.

Loss of temperature each minute after death during the first 15 minutes, 0°.0 C.; during the following 20 minutes 0°.04 C.; loss during the 35 following minutes, 0°.05 C.; during 60 following minutes, 0°.035 C.; during the 10 following minutes, 0°.024 C.; during the 100 following minutes, 0.0286° C. per minute.

Loss of temperature each minute, during 240 minutes after death, 0°.03229 C.

Post-mortem Examination: 240 minutes after death, rigor-mortis well marked. Powerful interrupted magneto-electric and electro-magnetic currents produced no effect whatever upon the muscles.

Dura-mater, adherent to cranium. Brain not congested with blood, and it presented a pale anæmic appearance. Spinal cord in like manner not congested with blood, but pale and anæmic. Careful microscopical observations, showed no alteration which could be referred to the action of the poison, either in the white or gray substances of the cerebellum, medulla oblongata and spinal cord. Upon the exterior the sympathetic presented the usual appearance of health, without any alterations which could be referred to the poison. No alterations which could be referred to the action of the poison could be found by the microscope, either in the nerve fibres or in the ganglionic cells.

The right auricle and ventricle of the heart contained numerous slender white worms, many of which were four inches in length.

The cavities of the heart just mentioned, contained also coagulable blood and a fibrinous concretion, which was entangled with the worms, and the carneæ columnæ and chordæ tendineæ, and which from its structure was without doubt, formed before death. Lungs not congested. The intestines and stomach both upon the exterior and upon the internal mucous surface, presented a normal non-congested appearance, which was in striking contrast to the appearance of the intestines of the dog examined after long periods had elapsed after death.

The veins of the stomach and intestines were distended with dark, almost black blood, and appeared to be filled almost to bursting with blood. These viscera were set aside, and in the course of 24 hours the blood or rather its coloring matter, passed into the surrounding tissues, and discolored them, so that they presented the peculiar congested appearance of the intestines in the previous cases.

This fact is interesting, in showing the effects of time alone upon the appearance of viscera, and the consequent necessity to estimate correctly post-mortem changes. Blood-vessels of liver and kidneys filled with dark blood. The blood contained numerous active larvæ of the worms which had not been affected by the poison. The colored blood corpuscles were not altered from the normal appearance.

Experiment 114: Action of Prussic Acid on large, male Cat.

Several drops of a strong solution of Prussic Acid were placed upon the tongue of this animal—the effects were manifest in a few moments, and at the expiration of 3 minutes, the respiration and action of the heart had ceased. After death, the cardiac rigidity was slow and imperfect, forming a striking contrast to cats killed at the same time with Strychnia. The blood coagulated perfectly a few moments after its abstraction, both before and after death; the clot was firm, and the separation of clear serum well marked. Under the microscope some of nervous system. The muscles connected with the cerebro-spinal system were affected to a much less degree than those related more especially to the sympathetic system.

Experiments 134, 135, 136, 137, 138, 139: Repetitions of preceding experiment, with similar results.

Experiment 140: Illustrating the action of Cyanide of Potassium on Warm-Blooded Animals.

Augusta, Ga., April 1st, 1860. Fine, large cur dog, very fat, fierce and powerful.

Temperature of rectum, 103°.59 F.

The attempt was first made to pass a strong interrupted current through the muscles of the thigh; during the cutting through the skin for positions for the terminals of the electrical apparatus, the dog struggled violently, and during these struggles there was a slight rise in the thermometer, which indicated 104° F. In a few minutes, however it fell to 103°.79 F. After the application of the electricity for a few seconds, his struggles were so violent, and his strength so great, (the muzzle was torn off and the dog bit the four young men who were assisting me in the experiment), that it was found to be impossible to continue the application of electricity, and a strong solution of Cyanide of Potassium was injected into the eyes and mouth.

In one minute, the struggles of the dog became violent, (he barked and gnashed his teeth and struggled in the most violent manner to break loose), and the dog died in six minutes after the solution of Cyanide of Potassium had been introduced into the eyes and mouth. Before death, the tongue and lips became of a brilliant scarlet color, and the tongue appeared to be swollen.

About three minutes before death, the dog became convulsed, the breathing became spasmodic; and at the moment of death, the muscles were violently convulsed, and the body and extremities were stretched backwards. The force of the death spasm was so great that the shaft of the glass thermometer, with its porcelain scale, in the rectum of the dog, was broken into small fragments.

Temperature of the rectum at the time of death, 41° C., 105°.8 F. During the violent spasms excited by the Cyanide of Potassium, the temperature had risen 1°01 F. Temperature of rectum 15 minutes after death, 41° C., 105°.8 F.; 88 minutes after death, 40° C., 104° F.; 99 minutes after death, 39°.33 C.; 209 minutes after death, 34°.5 C.; 234 minutes after death, 33°.75 C., 92°7 F.; 234 minutes after death, rigor-mortis well marked.

Post-mortem Examination, 20 hours after death: When the skull-cap was removed, the blood-vessels of the membranes and of the substance of the cerebrum and cerebellum were distended with dark blood. Blood-vessels of membranes and structures of medulla oblongata and spinal cord greatly congested with blood. As usual, the spinal cord was exposed throughout its entire length. Lungs and liver, stomach and intestines congested with blood.

Experiment 141: Illustrating the effects of Cyanide of Potassium on Warm-Blooded Animal.

Augusta, Georgia, January 23d, 1861. Thirty grains of Cyanide of Potassium were dissolved in two fluidounces of water, and half a fluiddrachm was injected sub-cutaneously beneath the skin of the left fore-leg of a cur dog. The poison excited violent struggles, loud and piercing cries; fullness of respiration, disturbance in the action of the heart—followed by slowness of respiration, and slow and spasmodic action of the heart. The beat fell in 19 minutes, to 40 beats to the minute. Then followed a long piercing cry; tetanic spasms, long drawn and loud breathing, coma, and finally death in 20 minutes after the injection of the poison. The animal in this experiment, unlike the one in the preceding experiment, died without a struggle.

Temperature of the rectum before the injection of the poison, 39°.46 C., 103° F.; of atmosphere, 50° F., during the period of excitement; during the first 10 minutes after the injection of the poison, the thermometer rose 0°.08 C., and stood at 39°.54 C. Temperature of rectum at moment of death, 38°.7 C., showing a descent of 0°.84 C.; during the period in which the respiration and heart actions decreased in frequency. Temperature of rectum 45 minutes after death, 37°.05; 75 minutes, 36° C.

Post-mortem, 24 hours after death. Veins of the brain distended with dark blood, which exhaled the odor of Prussic Acid. Brain normal in color and structure. Blood-vessels of brain less congested with blood than in the previous case of poisoning with Cyanide of Potassium.

Spinal cord normal in appearance.

Cavities of heart distended with dark fluid blood. Hepatic, Mesenteric and intestinal veins distended with dark fluid blood, as was the case also with the vena-cava. Arteries empty. Liver of a dark purplish, greatly congested appearance. Kidneys of a dark purplish slate color, and greatly congested with blood. Spleen dark colored and congested.

Lungs somewhat congested. Veins of stomach distended with blood; mucous surface much corrugated, contained thick ropy mucus, and was of a deep pink and purplish color.

Veins of small intestines much congested with blood; mucous membrane pale and not congested, except in the duodenum, near its junction with the stomach. The congestion of the mucous membrane of the stomach appeared to have been due to the local action of the poison.

Under the microscope the colored blood corpuscles, in some cases appeared to be smaller than normal, and in others, presented a stellate appearance. When abstracted from the body, the blood coagulated imperfectly.

Experiments 142, 143, 144, 145, 146, 147: Repetition of preceding Experiments (140 and 141), general results similar.

Experiment 148: Action of Acetate of Strychnia on large, active Dog.

Augusta, Georgia, May 14th, 1860. Fine, large, well conditioned, active dog. Temperature of atmosphere 24° C., 75°.2 F.; temperature of rectum of dog, 40°.2 C., 104°.4 F.; temperature of surface of muscles of small of back, an incision having been made through the skin, and the thermometer introduced, 37°.5 C., 99°.5 F.

Immediately after the sub-cutaneous injection of the Acetate of Strychnia solution, into the cellular tissue of the anterior portion of the right thigh, the temperature of the rectum commenced to descend, and fell $\frac{1}{5}$ of a degree C., 0.2° C. During the fall of the temperature, there was no disturbance of the muscular or nervous system. In two minutes after the injection of the solution of the Acetate of Strychnia, violent convulsive movements of the muscles were excited, and the pupils of the eyes were dilated. During these convulsions the thermometer in the rectum slowly rose, and in three minutes (5 minutes after the injection of the Acetate of Strychnia,) the thermometer stood at 40°.25 C., 104°.5 F; showing a rise of 0°.25 C., during the last three minutes. During this time the temperature of the surface of the muscles of the thigh, also rose, and stood at 38°.13 C., 100°.6 F.; showing a rise of 0°.63 C. At this time (5 minutes after the injection of the solution of Acetate of Strychnia,) the pulsations of the heart were 52 per minute, whilst the respiration had ceased. The pulsations of the heart were strong and spasmodic. One minute after this observation the heart ceased to beat.

If we consider the cessation of the heart's action, as the moment of death, then the Acetate of Strychnia (about one and a half grains), produced death in six minutes. The temperature of the rectum and of the surface of the muscles of the loins, commenced to descend almost immediately after the cessation of the action of the heart, and 4 minutes after temperature of rectum 40°.2 C.; of muscles of loins 37° C. In four minutes the temperature of the surface of the muscles of the loins had fallen 1°.12 C.; whilst that of the rectum had fallen only 0°.05 C. This difference was manifestly due to the relative loss of heat from the exterior and interior of a body by conduction and radiation. Temperature of rectum 10 minutes after death, 40° C.

A strong interrupted electro-magnetic current was then passed in various directions from the great nervous centres to the periphery and *vice versa*; contractions were produced in all the voluntary muscles; contortions of the muscles of the face, were in like manner produced. The contractions, thus excited, appeared however to be much more feeble than those produced in the muscles of animals killed by mechanical means.

Temperature of rectum 22 minutes after death, 39° C.; of surface of muscles of loins, 36°.16 C.

Thirty-two minutes after the cessation of the action of the heart, *rigor-mortis* had not taken place, and the dog presented no such contractions and contortions of the muscles, as have been said by some writers to be invariably characteristic of the bodies of animals and men, poisoned by strychnine.

Rigor-mortis commenced 7 minutes after this observation; that is 39 minutes after cessation of the action of the heart. Forty-two minutes after cessation of action of heart, temperature of rectum, 39°.2 C.; of surface of muscles of loins, 35°.33 C.; 72 minutes after cessation of action of heart, temperature of rectum, 37° C.: of muscles of loins, 34°.5 C. At this time the rigor-mortis is well marked, and the limbs are strongly contracted and rigid. A strong interrupted magneto-electric current, passed as before in various directions, produced no movements manifest to the eye; when, however, the skin was removed, contractions were visible in the muscular fibres, under the direct application of the interrupted currents. One hundred and ten minutes after death, temperature of rectum 36°.2 C.; temperature of surface of muscles of loins, 34°.55 C.; loss of temperature in rectum during 110 minutes after death, 4°.05 C., loss each minute, 0°.036; loss of temperature in muscles of loins during 110 minutes after death, 3°.58 C.; loss of temperature each minute, 0°.032 C.

Autopsy, 110 minutes after death.

The blood from the carotid arteries, from the vena cava, and from the cavities of the heart presented no unusual appearance under the microscope with the exception, that some of the colored blood corpuscles appeared a little swollen, and others presented a stellate, star-like appearance.

The blood-vessels of the membranes and structures of the brain and spinal cord, presented no marked congestion. The nerve cells of the gray matter of the brain and spinal cord presented under the microscope the usual healthy appearance. Lungs of a light pinkish color and not congested with blood. Heart contracted and normal in appearance. Liver congested with blood, and of a deep purplish and pinkish color, resembling the color of venous blood. The stomach was filled with undigested matters—exterior pale; interior mucous membrane of a pinkish and light purplish color, so often present during the progress of digestion. Surface of intestines pale; blood-vessels filled with dark cherry red and purplish venous blood. Spleen and pancreas, normal in appearance. Bladder greatly contracted. As in preceding experiment, colored drawings were executed of appearance of brain, spinal cord and viscera.

Experiment 149: Action of Acetate of Strychnia on Female Dog.

Augusta, Georgia, May 14th, 1960. Large, well conditioned female dog. Temperature of atmosphere, 24° C., 75°.2 F.; temperature of rectum, 40°.33 C., 104°.6 F.; temperature of surface of muscles of thigh, (the skin being cut and the thermometer introduced) 37°.8 C., 101°.9 F.

Injected about two grains of Acetate of Strychnia, in solution, into the sub-cutaneous tissue of the thigh of the hind leg. The poison acted in two minutes after its injection. During these two minutes the temperature remained stationary, then violent convulsions of all the muscles ensued; 6 minutes after the injection of the Acetate of Strychnia, temperature of rectum, 40°.55 C., 105° F., showing a rise of 0°.22 C. in 4 minutes. Temperatue of surface of muscles of thigh, 38° C., showing a rise of 0°.2 C., during the convulsions. The heart ceased to pulsate one minute after this observation, and 7 minutes after the injection of the Acetate of Strychnia into the sub-cutaneous tissue. There was a still further rise of 0°.05 C., during the last moments of life, and after death, the thermometer stood, 10 minutes after the cessation of the action of the heart, at 40°.6 C., 105°.1 F., in the rectum. At this time there was a strong peristaltic motion of the intestines. Temperature of surface of muscles, 36°.8 C., showing a fall in 10 minutes, of 1°.2 C. The temperature of the surface of the muscles commenced to sink immediately after the cessation of the respiration and of the pulsations of the heart. 20 minutes after the cessation of the action of respiration and circulation, temperature of rectum, 40°.56 C.; slight fall of 0°.04 C.; temperature of surface of muscles of loins 35°.4 C., loss of 1°.4 C.

A powerful interrupted electro-magnetic current was then applied, 28 minutes after death in various directions along the nervous centres; rigor-mortis had not as yet commenced. The muscles responded to the action of the electric currents, especially those of the head, ears and eyes, but to a much less degree than in animals killed by mechanical means, as when the medulla oblongata was severed. The currents were passed for several minutes through the entire length of the spinal cord, without any rise in the temperature of the rectum, or of the surface of the muscles. The effects upon the muscles of the extremities and trunk appeared to be less than upon the muscles of the face. 43 minutes after the cessation of the action of the heart, temperature of rectum, 39°.75 C.; of surface of muscles, 36°.; 173 minutes after cessation of heart, and 130 minutes after last observation, temperature of rectum, [illegible] C.; of surface of muscles, 33°.7 C.; 196, (23 after last observation), temperature of rectum, [illegible] C.; muscles, 33°.4 C.; temperature of atmosphere, 27° C.; 282 minutes, (186 after last observation), temperature of atmosphere, 26°.5 C.; of rectum, 34°.33 C.; of muscles, 32°.2 C.

Autopsy, 293 minutes after cessation of respiration and the action of the heart.

Rigor-mortis well marked. The blood corpuscles presented similar appearances as in the preceding case, some were a little swollen, others corrugated and stellated.

The brain and spinal cord presented no marked evidences of congestion. The base of the brain was more congested with blood than the superior portions. The microscopical examination of the structures of the brain, spinal cord and sympathetic, did not reveal any recognizable alterations or lesions. I could detect no alterations in the nerve cells or commissures of the cerebrum, cerebellum, pons varolii, medulla oblongata, or spinal cord and sympathetic, which would distinguish the action of strychnia from that of Prussic Acid. Lungs greatly congested; the liver, on the other hand, pale and bloodless. Stomach filled with digested matters, and presented a much redder appearance upon the exterior and interior than in the preceding experiment. Intestines, spleen, bladder and pancreas normal.

which possess organs of generation. Hunter regarded the heart as a truly mechanical engine:

> "For although muscles are the powers in an animal, yet these powers are themselves often converted into a machine, of which the heart is a strong instance; for, from the disposition of its muscular fibres, tendons, ligaments and valves, it is adapted to mechanical purposes, and this construction makes it a complete organ or machine in itself."—Treatise on the Blood and Inflammation, 1793.

Xavier Bichat, in his work on "Life and Death," 1799, held that no direct influence is exercised by the brain over the heart, which, on the contrary, is immediately dependent, with regard to its operations, on the movement communicated to it by the blood. Bichat attempted to sustain this proposition by the facts, that: 1st, all violent irritation of the brain produces either partial or general convulsion in the muscles of animal life, but no such effect upon the muscles of organic life; 2d, all compression of the cerebral mass has ordinarily the effect of paralyzing the voluntary muscles, but so long as the affection does not extend to the respiratory muscles, the action of the heart is in no degree diminished; 3d, Opium and Wine, when taken in a certain quantity, diminish the cerebral energy, and render the brain unfit for the functions of the animal life, the action of the heart, on the contrary is increased; 4th, in palpitation and the different irregular movements of the heart, it is not observable that the principle of these derangements exists in the brain; 5th, the numerous phenomena of apoplexy and epilepsy, concussion, etc., do all of them certainly tend to show how independent the heart is of the brain; 6th, every organ which is subject to the direct influence of the brain, is, for that very reason, an organ of volition; the heart, on the contrary, is not subject to the volition. Bichat endeavored to establish the independence of the actions of the heart from those of the cerebro-spinal system, by the following experiments:

> 1st. If the brain of an animal be exposed and irritated, either with mechanical or chemical agents, a variety of alterations will indeed be produced in the organs of the animal life, but none in the heart so long as the muscles of the breast continue to perform their functions.
>
> 2d. Experiments made in the same manner upon the spinal marrow of the neck, present the same results.
>
> If the eighth pair of nerves be irritated, the movements of the heart will not be accelerated; they will not be arrested if these two nerves be divided. In all these experiments, however, we must be careful to make a proper distinction between the emotions and passions of the animal, and what it really suffers from the experiment.
>
> 4th. The nature of the great sympathetic nerve is supposed to be known; now, if the same experiments be made on the cardiac branches of the nerve, as were made upon the eighth pair, the same results will follow.

Sir B. C. Brodie, in the series of experiments which he instituted, to ascertain how far the influence of the brain is necessary to the action of the heart, found that when an animal was pithed, by dividing the spinal marrow in the upper part of the neck, respiration was immediately destroyed, but the heart still continued to contract, circulating dark colored blood, and in some instances, from ten to fifteen minutes elapsed before its action had entirely ceased; when the head was removed, the divided blood-vessels being secured by a ligature, the circulation still continued, apparently unaffected by the entire separation of the brain; when artificial respiration was instituted in the beheaded animals, the heart continued in some instances to contract for two hours, with apparently as much strength and frequency as in a living animal. From these experiments, Sir Benjamin Brodie concluded, that "The influence of the brain is not necessary to the action of the heart; and that when the brain is injured or removed, the action of the heart ceases only because respiration is under its influence, and if, under these circumstances, respiration is artificially produced, the circulation will still continue."—Phil. Trans., 1811, pp. 36–48.

Sir Benjamin Brodie, from his experiments upon the action of Alcohol, concluded that the symptoms produced by a large quantity of spirits taken into the stomach, arise entirely from disturbance of the function of the brain; the complete insensibility to external impressions; the dilatation of the pupil of the eye, and the loss of motion, indicate that the functions of this organ are suspended; respiration, which is under its influence, is ill-performed, and at last altogether ceases; while the heart, to the action of which the brain is not directly necessary, continues to contract, circulating dark colored blood for some time afterwards. His experiments upon the action upon living animals of the essential oil of Almonds, the juice of the leaves of Aconite, of the Upas Antiar, the oil of Tobacco, Arsenic, Muriate of Barytes, Tartar Emetic and Woorara, in like manner convinced him that poisons might act directly upon the cerebro-spinal system, destroying all its functions, without interfering with the actions of the heart, whilst, on the other hand, poisons may act upon the heart, causing death from such action, without specially acting upon the cerebro-spinal nervous system.—Phil. Trans., 1811, pp. 178–208; Phil. Trans., 1812, pp. 205–227.

We have already considered, in the first chapter of the Medical Memoirs and in the present chapter, the experiments of LeGallois, and endeavored to show that they not only established the fact that the spinal cord is the especial seat of the reflex actions, but also that the continuance of the action of the heart after decapitation and the destruction of the spinal cord, is dependent rather upon the respiration than upon any nervous influence transmitted from the cerebro-spinal ganglionic centres.

The correctness of this view is sustained by the remarkable experiment, in which Le Gallois maintained the action of the heart and "life," for upwards of three-quarters of an hour, in the detached and isolated breast of a rabbit thirty days old. In this experiment, the belly of the animal was first opened, a ligature passed around the aorta, immediately below the Cœliac trunk, another was passed around the vena-cava near the liver: a simple knot was tied in each of these ligatures. This being done, the trachea and both carotids were laid bare; each of these arteries were tied conjointly with the external and internal jugular veins; the trachea opened for the inflation of the lungs; the spinal marrow was then divided with a needle, near the occiput, and artificial respiration instituted, without waiting until the asphyxia had extinguished sensation; after it had been continued for three or four minutes, the animal being fully alive, the trachea is separated forward from the larynx, then the head is cut off at the first vertebræ of the neck, with a pair of scissors; and immediately resuming the inflation, which is to be continued for three or four minutes, after which the knots are to be tightened, which had been previously prepared upon the aorta and the inferior vena-cava; the inflation is then to be renewed, and again interrupted, at the end of three or four minutes, to cut off the hind parts, which is performed by taking away the intestinal tube from the beginning of the duodenum, then by dividing with scissors the soft parts surrounding the vertebral column, and then the column itself, immediately below the ligatures made on the aorta and the vena-cava. In this manner, there remains only the breast, the stomach and the liver, which might also be removed if care be taken to prevent hæmorrhage. The operation being finished, all that remains is to continue inflation of the lungs, as long as the breast has any signs of life. The most apparent of these signs, are the motions and the sensations preserved in the fore feet, and the small writhing motions observed in the thorax, when the skin is severely pinched, and when the posterior extremity of the dorsal portion of the medulla spinalis is touched. In some cases after carrying the experiment thus far, the remainder of the cervical portion of the medulla spinalis and part of the dorsal were destroyed, and although life existed only in the two posterior thirds of the breast it could still be prolonged.
Experiments on the Principle of Life, etc.

Dr. A. P. Wilson Philip, whose experiments upon cold-blooded animals we have already considered, also examined the relations of the heart to the cerebro-spinal nervous system, and demonstrated the independence of the action of the heart by such experiments as the following:

Dr. Philip deprived a rabbit of sensation and voluntary power, by a stroke on the occiput and supported the circulation by artificial respiration. The spinal marrow was then laid bare from the occiput to the beginning of the dorsal vertebræ, the chest was opened and the heart found beating regularly, and with considerable force. The spinal marrow, as far as it had been laid bare, was now wholly removed, but without the least affecting the action of the heart. After this the artificial respiration being frequently discontinued, the action of the heart became languid and increased on renewing it. The skull was then removed, and the whole of the brain removed, so that no part of the nervous system remained above the dorsal vertebræ, but without any abatement of the action of the heart, which still continued to be more or less powerful, according as we discontinued or renewed artificial respiration. This being for a considerable time discontinued, the ventricles ceased to beat about half an hour after the removal of the brain. On renewing the respiration, however, the action of the ventricles was restored. The respiration was again discontinued and renewed with the same effects. In another rabbit rendered insensible, and the circulation supported by artificial respiration, and the thorax opened and the heart carefully observed, the spinal marrow was destroyed throughout its whole length by a hot wire. The action of the heart was not at all affected. These experiments were repeated and varied in some instances, by the destruction of both the brain and spinal cord—in each case the result was the same; no special effect was produced upon the heart; and Dr. Philip satisfied himself that the circulation was continued in the usual way, and with sufficient force in the distant part. Philosophical Transactions, 1815, pp. 65–90; Phil. Trans., 1815, pp. 424–446.

Dr. Philip, in his last paper published in the Philsophical Transactions of 1836, which he states, comprehends the results of the investigations of his life, expresses his belief, that neither the brain nor spinal marrow bestows any power on the heart or vessels; but that on the other hand, each of these organs is equally capable of directly influencing both, (the vessels even to their utmost extremities,) and that not only by exciting their powers, but also by impairing and even wholly destroying them, according to the nature and power of the agent operating on the brain or spinal marrow; although in their usual functions, the heart and vessels like the other muscles of involuntary motion obey neither of these organs, but agents peculiar to themselves. Phil. Trans., 1836, pp. 346–348.

Sir Charles Bell held that the ordinary action of the heart is dependent upon the ganglionic system, but that its connexion with the respiratory and sensorial functions was derived through the cerebro-spinal nerves or par-vagum. Thus, after demonstrating the extensive connections and offices of the respiratory nerves, he thus proceeds to illustrate the mode in which the mind influences the body during emotion or passion:

"In terror, we can readily conceive why a man stands with eyes intently fixed on the object of his fears; the eyebrows elevated, and the eye balls largely uncovered; or why, with hesitating and bewildered steps, his eyes are rapidly and wildly in search of something. In this we only perceive the intent application of his mind to the objects of his apprehensions, and its direct influence on the outward organs. But when we observe him farther there is a spasm on his breast; he cannot breathe freely; the chest remains elevated, and his respiration is short and rapid; there is a gasping and convulsive motion of his lips; a tremor on his hollow cheeks; a gulping and catching of his throat; his heart knocks at his ribs, while yet there is no force in the circulation, the lips and cheeks being ashy pale.

It is obvious that there is here a reflected influence in operation. The language and sentiments of every people have pointed to the heart as the seat of passion, and every individual must have felt its truth. For though the heart be not in the proper sense the seat of passion, it is influenced by the conditions of the mind, and from thence its influence is extended through the respiratory organs, so as to mount to the throat and lips and cheeks, and account for every movement in passion which is not explained by the direct influence of the mind on the features." Phil. Trans., 1822, pp. 307, 308.

Prior to Scarpa, many eminent anatomists, as Haller, Wisberg, Soemmering and others, appeared from their descriptions to hold the view, that no nerves are distributed to the muscular substance of the heart, and that its contractions were independent of nervous influence. James Benignus Winslow, in his *Anatomical Explanation of the Structure of the Human Body*, (which appears from the author's preface to have been composed in 1722, but not published until some ten years after,) describes the "*Plexus*

Cardiacus," as being formed by communicating branches of the *Eighth Pair*, and the *Intercostal* or *Great Sympathetic Nerve*. According to this eminent anatomist,

> "The Plexus Cardiacus, is formed above the lung, on the fore side of the Bronchia, and produces a great number of filaments; some of which go to the Pericardium, and then pass through it, round the great vessels to be distributed to the heart."

Winslow states that while some of the filaments from the cardiac plexus, run down over the trunks of the great blood-vessels, and over the auricles and ventricles of the heart, other and the chief filaments run in the cellular substance behind the aorta, and between that and the trunk of the pulmonary artery, and after being divided into a great many small nerves, which run before and behind the aorta, are distributed to the base and auricles of the heart. In Winslow's description of the mode of action and uses of the heart, he makes no reference to the nerves distributed to its substance.

William Cheselden, in his Anatomy of the Human Body, gives no description of the nerves of the heart; he appeared however to be aware of their relations to its actions, from the ingenious attempt to account for the systole and diastole of the heart, and the reciprocal actions of the auricles and ventricles, which he quotes from Mr. Munro. *Anatomy of the Human Body*; ix Ed., London, 1768, pp. 197, 199.

B. J. Behrends (a pupil of Soemmering,) who whilst admitting in his *Dissertatio qua demonstratur Cor Nervis Carrere, 1792*, that nerves accompany the Coronary Arteries, distinctly asserted that the muscular structure is entirely destitute of nerves.

Scarpa, clearly delineated and described nerves running on the heart independent of, and distinct from the Coronary Arteries, and in his elaborate work (*Tabulæ Neurologicæ*, 1794,) has given fine views of the nerves of the human heart, in some of which, upwards of twenty filaments may be counted on the same transverse line, near the base of the heart, together with numerous anastomotic angular enlargements, which Scarpa does not specify as ganglions in his text. In the hearts of the large herbivorous Mammalia, however, Scarpa describes and delineates both ganglia and fusiform enlargements of the nerves, which he called corpora olivaria, and these not only upon the nerves at the base of the heart, but upon those that are spread over the superficies of the ventricle. Scarpa also describes and figures several nerves independent of, and not accompanying the blood-vessels of the heart, and avails himself of the fact to refute the conclusions to which Behrends had arrrived.

In Mr. Swan's splendid plates, the nerves are represented as accompanying the Coronary Arteries, and but few are distributed to the muscular tissue, and M. Chassaignac who translated in 1838, Mr. Swan's "Demonstration of the Nerves of the Human Body," denies that any nerves besides those which accompany the Coronary Arteries have ever been discovered in the heart.

Mr. Robert Lee, in an important paper published in the *Philosophical Transactions of the Royal Society*, 1849, pp. 43, 47, has demonstrated by careful directions and drawings, that the nerves and ganglia of the heart are far more numerous than those described and delineated by Scarpa. The series of dissections performed by Mr. Lee show that the nerves of the heart which are distributed over its surface and throughout its walls to the lining membrane and columnæ carneæ, enlarge with the natural growth of the heart, before birth, and during childhood and youth, until the heart has attained its full size in the adult, that the nervous supply of the left ventricle is greater than that of the right; and that when the walls of the auricles and ventricles are affected with hypertrophy, the ganglia and nerves of the heart are enlarged, like those of the gravid Uterus. In one of the dissections of the heart, on the anterior surface, there were distinctly visible to the naked eye, ninety ganglia or ganglionic enlargements of the nerves which pass obliquely across the arteries and the muscular fibres of the ventricles from their base to the apex. These ganglionic enlargements are observed on the nerves, not only where they cross the arteries, but where they ramify on the muscular substance, without the blood-vessels. On the posterior surface, the principal bran

ronary Arteries plunge into the muscular substance of the heart near the base,
nerves with ganglia accompany them throughout the walls to the lining mem-
columnæ carneæ. From thes udden disappearance of the chief branches of
ary Arteries on the posterior surface, the nervous structure distributed over a
ble portion of the left ventricle, is completely isolated from the blood-vessels,
ese, numerous ganglionic enlargements are likewise observed, but smaller in
the chains of ganglia formed over the blood-vessels on the anterior surface of
. Mr. Lee, has clearly demonstrated that every artery distributed throughout
of the Uterus and Heart, and every muscular fasciculus of these organs, is
with nerves, upon which ganglia are formed.

ld be foreign to my purpose to examine critically the theories advanced by
riters as to the cause and nature of the heart's action; we desired simply to
h experiments and anatomical facts, as were directly related to the question
sideration.

he preceding inquiry, and from an extended examination of the views of many
esides those quoted, and from actual experiments and dissections, the following
s may be drawn:

Both experiment and pathological observations show that the action of the
y be influenced through the pneumogastric nerves, through the cerebro-
tres: thus its action is disturbed, or even abruptly suspended. by severe injury
tion of the brain or spinal cord; and its action is excited or depressed by the
and passions, or by various diseases of the brain.

evertheless the movements of the heart do not depend upon the cerebro-spinal
ystem, because it continues its pulsations after the brain and spinal cord have
oved; and if the injury either to the cerebro-spinal or sympathetic system be
inflicted, the heart's movements will continue with slight perturbations, even
the entire brain and spinal cord be removed, if artificial respiration be
d.

he regulating agents of the heart's movements exist around and within the
lf; the numerous sympathetic ganglia connected with the nerves of the heart,
ources of the stimulus or force which excites the rythmical contractions of its
When the rythmical movements of a part depend on a nervous centre, they
ediately after the connection between these parts and the nervous centre is
thus the rythmical movements of the muscles of respiration, depend on the
blongata, and as soon as this is destroyed they cease; in like manner, if the
the heart depended on the medulla oblongata, or on any other portion of
ro-spinal system, it would cease pulsating as soon as it is removed from the
of its cerebro-spinal centre; but Bidder and others have shown that the heart
its pulsations, and the circulation continues, if the respiration be maintained,
plete destruction of the brain and spinal cord.

The cardiac ganglia must be regarded as nervous centres, which originate or
he force, which stimulates the muscular fibres of the auricles and ventricles,
their characteristic movements in regular and periodic succession; and the
us combination of the auricular and ventricular motions on the two sides in
e heart of warm-blooded animals, is without doubt due to connections between
l ganglia; therefore the movements exhibited by the heart after the central
the nervous system have been destroyed, are not mere movements of irritation,
inherent irritability of the muscular fibres, acted on by the stimulus of the
ether arterial or venous, and the thermic and electric currents developed by
l reactions and chemical changes of the muscle and blood. Mere *muscular*
y, (although its existence is not denied, but strenuously maintained,) excited
mulus of venous or arterial blood, or by the absence or presence of the oxygen
od and atmosphere, will not explain the simultaneous contraction of both
both ventricles, or the successive contractions and expansions of the auricles
icles; the rythmical order of these contractions, like the movements of the

respiratory muscles, must be regulated by special nervous centres. If the hypothesis previously unfolded, as to the close relationship, if not absolute identity of electricity and nervous and muscular force be adopted, the continuous and rythmical action of the heart may be comprehended; and we also find in this theory an explanation of the effects of mechanical stimuli and chemical agents and variations in the amount and character of the blood and nutrition of the organ, in exciting or depressing the heart's action, and also of the mode in which the cerebro-spinal nervous system may exert an action on this organ, through the pneumogastric and sympathetic.

5th. The heart therefore, like all muscles, possesses motor nerves, which communicate to its fibres motor impulses. The motor nerves of the heart are excited by the centres situated in the heart itself, and which act independently of the cerebro-spinal nervous system, and of the will, and are excited by variations in the temperature and chemical composition of the blood. Although receiving its motor impulses from its own ganglia, the heart is connected with the cerebro-spinal centres by centrifugal and centripetal fibres, which, on the one hand, under the influence of cerebral excitations, modify both the rythm and force of its contractions, and on the other, communicate to the brain and spinal cord a series of sensations and impressions corresponding to the character of its movements.

6th. Poisons may act directly upon the ganglionic centres of the heart, on which its movements depend, deranging that concert of nervous impulses upon which the regular succession of the contractions of the auricles and ventricles depend, and even destroying totally the nervous power and muscular irritability of the heart; poisonous agents may also influence the action of the heart by their effects on the cerebro-spinal nervous system; but the derangements thus produced by reflex action, are comparatively insignificant and unimportant.

This last proposition, which was fully illustrated and demonstrated by the experiments on cold-blooded animals, needs further illustration and demonstration with warm-blooded animals, and we accordingly devised and performed the following additional experiments:

EXPERIMENTS TO DETERMINE WHETHER PRUSSIC ACID, CYANIDE OF POTASSIUM AND STRYCHNIA, EXERT ANY DIRECT AND SPECIAL ACTION ON THE HEART, INDEPENDENT ALTOGETHER OF THE ACTION OF THESE AGENTS ON THE CEREBRO-SPINAL NERVOUS SYSTEM.

Experiment 126: Preliminary, to determine the relations of the Heart to the Cerebro-Spinal Nervous System, to the Lungs, and to the Sympathetic Nervous System; Effects on the action of the Heart, of division of the Medulla Oblongata.

A knife blade was passed through the vital point, severing the medulla oblongata and also the vertebral arteries of a large Pointer dog. The respiration ceased immediately; the hæmorrhage was profuse, and in a few moments all signs of life were extinct. The thorax was opened by the removal of the sternum, several minutes after the pulsations of the heart had ceased, and the animal was apparently dead. When the heart was pricked with a scalpel it immediately pulsated. Artificial respiration was instituted, and the cavities of the heart contracted and expanded as in living, healthy animals. When the intestines were pricked by the end of the scalpel, the peristaltic motions were excited vigorously. The interrupted electro-magnetic current produced powerful contractions of the voluntary muscles; the limbs were tossed about in the wildest manner, the mouth was opened and shut, and all the expressions, of which a dog is capable, were formed in rapid succession, according to the direction in which the currents were passed, and if the dog had been placed in the standing posture, it would have been possible to have caused him to bound with the force of health, from the table. The heart and intestines also responded to the electrical currents readily and vigorously. The heart continued to beat with vigor and regularity for more than one hour, during which time, the artificial respiration was carefully performed. This experiment, which has been performed before by numerous observers, with the same result, demonstrates that the action of the heart is indispensably connected with respiration, and may be maintained after the nervous centre which presides over respiration has been entirely destroyed and severed from the respiratory apparatus, if the respiratory acts of the alternate inflation and expiration of the lungs be mechanically performed.

Experiments 127, 128, 129, 130, 131, 132: Repetitions of preceding experiment (126), with similar results.

Experiment 133: Illustrating action of Prussic Acid on Warm-Blooded Animal.

Augusta, Ga., January 30th, 1861. Fine, large, Pointer dog. Temperature of atmosphere, 60° F.; temperature of rectum of dog, 40° C., 104° F.

Four fluiddrachms of the officinal solution of Prussic Acid were injected into the sub-cutaneous tissue of the right thigh. As soon as the nozzle of the syringe was removed, a large portion of the solution was ejected. In a few moments, the muscles of the neighborhood of the part injected commenced to twitch; then the dog, in two minutes, manifested great uneasiness; the respiration became fuller, and the action of the heart slower. These phenomena were succeeded by violent struggles and piercing cries, as if the dog was suffering intense agony. During these violent struggles, the temperature of the rectum rose 0°.3 C. At the end of 12 minutes, the dog was still exerting great strength, struggling violently, and emitting piercing cries. Half a fluidounce of the officinal solution of Prusic Acid was then poured into the mouth and nostrils; the effects were manifested in a few seconds; the respiration became more labored, and the action of the heart slower; strong tetanic spasms, coma and finally death, in three minutes. The respiration became spasmodic, and occurred at long intervals before death. Before death the action of the heart was exceedingly feeble, and could scarcely be felt through the walls of the thorax. Immediately after the cessation of the action of the heart, the thorax was opened; the heart was distended to its utmost capacity with dark, almost black blood; not the slightest motion was perceived in either the auricles or ventricles. When the pericardium was opened, and the auricles and ventricles irritated with a steel point, there was no motion whatever excited in the muscular structures. When grasped in the hands, no motion whatever could be felt. The pectoral, respiratory, and other muscles of voluntary motion, as well as the diaphragm, responded readily to mechanical stimuli, and contracted vigorously. The intestines appeared to have lost, in great measure, their power of peristaltic motion, and responded but feebly to mechanical irritation. Artificial respiration was immediately instituted; the opening of the thorax, and the performance of the preceding experiments, consumed less than one minute.

Although the artificial respiration was kept up for more than one hour, *not the slightest motion of the heart was produced.* The heart was carefully and firmly grasped in the hand, but not the slightest contraction or motion of its muscular fibres could be perceived.

A strong, interrupted, galvanic current was passed through the heart after the establishment of artificial respiration, but no contraction could be perceived or felt. The interrupted electrical current, on the other hand, produced powerful contractions in all the voluntary muscles, the diaphragm contracted with great violence, the jaws were brought together with such force as to bend the steel wires of the muzzle, which were accidentally caught between the teeth. Every contortion and expression of the muscles of the face were induced, and the eyes opened, and shut, and winked in response to the electrical excitement. The peristaltic motion of the intestines, on the other hand, was with great difficulty excited, and then only very feebly, by the electrical current.

Temperature of the rectum, 15 minutes after death, 40°.25 C., 104°.4 F.; the temperature fell 0°.05 C. during this time, as it stood at 40°.3 C. at the moment of death. The large venous trunks and the blood-vessels of the liver and intestines were distended with dark, venous blood. The liver presented a deep purplish, almost black color. As soon as the heart failed to respond to artificial respiration, and mechanical and electrical stimuli, supposing that its extreme distension with blood might, in a measure retard its action, I punctured the heart, and allowed the blood to escape; a large quantity of the dark, fluid blood escaped from the cavities, which coagulated in a few minutes.

The heart, thus relieved, notwithstanding that death had taken place only a minute or two before, failed to respond to artificial respiration, and mechanical and electrical stimulation.

Temperature of the rectum 30 minutes after death, 39° C.; 45 minutes after death, 37° C. The rapid cooling was due to the artificial respiration, loss of blood, and exposure of the internal organs. The muscles were dark colored and bloodless; the whole mass of blood appeared to have accumulated in the large venous trunks and capillaries of the internal organs. Reaction of blood of heart slightly alkaline.

The preceding experiment demonstrated conclusively that Prussic Acid acts directly upon the heart, arresting its action, and also to a certain degree upon the sympathetic nervous system. The muscles connected with the cerebro-spinal system were affected to a much less degree than those related more especially to the sympathetic system.

Experiments 134, 135, 136, 137, 138, 139: Repetitions of preceding experiment, with similar results.

Experiment 140: Illustrating the action of Cyanide of Potassium on Warm-Blooded Animals.

Augusta, Ga., April 1st, 1860. Fine, large cur dog, very fat, fierce and powerful.

Temperature of rectum, 103°.59 F.

The attempt was first made to pass a strong interrupted current through the muscles of the thigh; during the cutting through the skin for positions for the terminals of the electrical apparatus, the dog struggled violently, and during these struggles there was a slight rise in the thermometer, which indicated 104° F. In a few minutes, however it fell to 103°.75 F. After the application of the electricity for a few seconds, his struggles were so violent, and his strength so great, (the muzzle was torn off and the dog bit the four young men who were assisting me in the experiment), that it was found to be impossible to continue the application of electricity, and a strong solution of Cyanide of Potassium was injected into the eyes and mouth.

In one minute, the struggles of the dog became violent, (he barked and gnashed his teeth, and struggled in the most violent manner to break loose), and the dog died in six minutes after the solution of Cyanide of Potassium had been introduced into the eyes and mouth. Before death, the tongue and lips became of a brilliant scarlet color, and the tongue appeared to be swollen.

About three minutes before death, the dog became convulsed, the breathing became spasmodic; and at the moment of death, the muscles were violently convulsed, and the body and extremities were stretched backwards. The force of the death spasm was so great that the shaft of the glass thermometer, with its porcelain scale, in the rectum of the dog, was broken into small fragments.

Temperature of the rectum at the time of death, 41° C., 105°.8 F. During the violent spasms excited by the Cyanide of Potassium, the temperature had risen 1°01 F. Temperature of rectum 15 minutes after death, 41° C., 105°.8 F.; 88 minutes after death, 40° C., 104° F.; 99 minutes after death, 39°.33 C.; 209 minutes after death, 34°.5 C.; 234 minutes after death, 33°.75 C., 92°7 F.; 234 minutes after death, rigor-mortis well marked.

Post-mortem Examination, 20 hours after death: When the skull-cap was removed, the blood-vessels of the membranes and of the substance of the cerebrum and cerebellum were distended with dark blood. Blood-vessels of membranes and structures of medulla oblongata and spinal cord greatly congested with blood. As usual, the spinal cord was exposed throughout its entire length. Lungs and liver, stomach and intestines congested with blood.

Experiment 141: Illustrating the effects of Cyanide of Potassium on Warm-Blooded Animal.

Augusta, Georgia, January 23d, 1861. Thirty grains of Cyanide of Potassium were dissolved in two fluidounces of water, and half a fluiddrachm was injected sub-cutaneously beneath the skin of the left fore-leg of a cur dog. The poison excited violent struggles, loud and piercing cries; fullness of respiration, disturbance in the action of the heart—followed by slowness of respiration, and slow and spasmodic action of the heart. The beat fell in 10 minutes, to 40 beats to the minute. Then followed a long piercing cry; tetanic spasms, long drawn and loud breathing, coma, and finally death in 20 minutes after the injection of the poison. The animal in this experiment, unlike the one in the preceding experiment, died without a struggle.

Temperature of the rectum before the injection of the poison, 39°.46 C., 103° F.; of atmosphere, 50° F., during the period of excitement; during the first 10 minutes after the injection of the poison, the thermometer rose 0°.08 C., and stood at 39°.54 C. Temperature of rectum at moment of death, 38°.7 C., showing a descent of 0°.84 C.; during the period in which the respiration and heart actions decreased in frequency. Temperature of rectum 45 minutes after death, 37°.05; 75 minutes, 36° C.

Post-mortem, 24 hours after death. Veins of the brain distended with dark blood, which exhaled the odor of Prussic Acid. Brain normal in color and structure. Blood-vessels of brain less congested with blood than in the previous case of poisoning with Cyanide of Potassium.

Spinal cord normal in appearance.

Cavities of heart distended with dark fluid blood. Hepatic, Mesenteric and intestinal veins distended with dark fluid blood, as was the case also with the vena-cava. Arteries empty. Liver of a dark purplish, greatly congested appearance. Kidneys of a dark purplish slate color, and greatly congested with blood. Spleen dark colored and congested.

Lungs somewhat congested. Veins of stomach distended with blood; mucous surface much corrugated, contained thick ropy mucus, and was of a deep pink and purplish color.

Veins of small intestines much congested with blood; mucous membrane pale and not congested, except in the duodenum, near its junction with the stomach. The congestion of the mucous membrane of the stomach appeared to have been due to the local action of the poison.

Under the microscope the colored blood corpuscles, in some cases appeared to be smaller than normal, and in others, presented a stellate appearance. When abstracted from the body, the blood coagulated imperfectly.

Experiments 142, 143, 144, 145, 146, 147: Repetition of preceding Experiments (140 and 141), general results similar.

Experiment 148: Action of Acetate of Strychnia on large, active Dog.

Augusta, Georgia, May 14th, 1860. Fine, large, well conditioned, active dog. Temperature of atmosphere 24° C., 75°.2 F.; temperature of rectum of dog, 40°.2 C., 104°.4 F.; temperature of surface of muscles of small of back, an incision having been made through the skin, and the thermometer introduced, 37°.5 C., 99°.5 F.

Immediately after the sub-cutaneous injection of the Acetate of Strychnia solution, into the cellular tissue of the anterior portion of the right thigh, the temperature of the rectum commenced to descend, and fell ⅕ of a degree C., 0.2° C. During the fall of the temperature, there was no disturbance of the muscular or nervous system. In two minutes after the injection of the solution of the Acetate of Strychnia, violent convulsive movements of the muscles were excited, and the pupils of the eyes were dilated. During these convulsions the thermometer in the rectum slowly rose, and in three minutes (5 minutes after the injection of the Acetate of Strychnia,) the thermometer stood at 40°.25 C., 104°.5 F; showing a rise of 0°.25 C., during the last three minutes. During this time the temperature of the surface of the muscles of the thigh, also rose, and stood at 38°.13 C., 100°.6 F.; showing a rise of 0°.63 C. At this time (5 minutes after the injection of the solution of Acetate of Strychnia,) the pulsations of the heart were 52 per minute, whilst the respiration had ceased. The pulsations of the heart were strong and spasmodic. One minute after this observation the heart ceased to beat.

If we consider the cessation of the heart's action, as the moment of death, then the Acetate of Strychnia (about one and a half grains), produced death in six minutes. The temperature of the rectum and of the surface of the muscles of the loins, commenced to descend almost immediately after the cessation of the action of the heart, and 4 minutes after temperature of rectum 40°.2 C.; of muscles of loins 37° C. In four minutes the temperature of the surface of the muscles of the loins had fallen 1°.12 C.; whilst that of the rectum had fallen only 0°.05 C. This difference was manifestly due to the relative loss of heat from the exterior and interior of a body by conduction and radiation. Temperature of rectum 10 minutes after death, 40° C.

A strong interrupted electro-magnetic current was then passed in various directions from the great nervous centres to the periphery and *vice versa*; contractions were produced in all the voluntary muscles; contortions of the muscles of the face, were in like manner produced. The contractions, thus excited, appeared however to be much more feeble than those produced in the muscles of animals killed by mechanical means.

Temperature of rectum 22 minutes after death, 39° C.; of surface of muscles of loins, 36°.16 C.

Thirty-two minutes after the cessation of the action of the heart, *rigor-mortis* had not taken place, and the dog presented no such contractions and contortions of the muscles, as have been said by some writers to be invariably characteristic of the bodies of animals and men, poisoned by strychnine.

Rigor-mortis commenced 7 minutes after this observation; that is 39 minutes after cessation of the action of the heart. Forty-two minutes after cessation of action of heart, temperature of rectum, 39°.2 C.; of surface of muscles of loins, 35°.33 C.; 72 minutes after cessation of action of heart, temperature of rectum, 37° C.: of muscles of loins, 34°.5 C. At this time the rigor-mortis is well marked, and the limbs are strongly contracted and rigid. A strong interrupted magneto-electric current, passed as before in various directions, produced no movements manifest to the eye; when, however, the skin was removed, contractions were visible in the muscular fibres, under the direct application of the interrupted currents. One hundred and ten minutes after death, temperature of rectum 36°.2 C.; temperature of surface of muscles of loins, 34°.55 C.; loss of temperature in rectum during 110 minutes after death, 4°.05 C., loss each minute, 0°.036; loss of temperature in muscles of loins during 110 minutes after death, 3°.58 C.; loss of temperature each minute, 0°.032 C.

Autopsy, 110 minutes after death.

The blood from the carotid arteries, from the vena cava, and from the cavities of the heart presented no unusual appearance under the microscope with the exception, that some of the colored blood corpuscles appeared a little swollen, and others presented a stellate, [illegible] appearance.

The blood-vessels of the membranes and structures of the brain and spinal cord, presented no marked congestion. The nerve cells of the gray matter of the brain and spinal cord presented under the microscope the usual healthy appearance. Lungs of a light pink color and not congested with blood. Heart contracted and normal in appearance. Liver congested with blood, and of a deep purplish and pinkish color, resembling the color of venous blood. The stomach was filled with undigested matters—exterior pale; internal mucous membrane of a pinkish and light purplish color, so often present during the progress of digestion. Surface of intestines pale; blood-vessels filled with dark cherry red and purplish venous blood Spleen and pancreas, normal in appearance. Bladder greatly contracted. As in preceding experiment, colored drawings were executed of appearance of brain, spinal cord and viscera.

Experiment 149: Action of Acetate of Strychnia on Female Dog.

Augusta, Georgia, May 14th, 1960. Large, well conditioned female dog. Temperature of atmosphere, 24° C., 75°.2 F.; temperature of rectum, 40°.33 C., 104°.6 F.; temperature of surface of muscles of thigh, (the skin being cut and the thermometer introduced) 37°.8 101°.9 F.

Injected about two grains of Acetate of Strychnia, in solution, into the sub-cutaneous tissue of the thigh of the hind leg. The poison acted in two minutes after its injection. During these two minutes the temperature remained stationary, then violent convulsions of all the muscles ensued; 6 minutes after the injection of the Acetate of Strychnia, temperature of rectum, 40°.55 C., 105° F., showing a rise of 0°.22 C. in 4 minutes. Temperatue of surface of muscles of thigh, 38° C., showing a rise of 0°.2 C., during the convulsions. The heart ceased to pulsate one minute after this observation, and 7 minutes after the injection of the Acetate of Strychnia into the sub-cutaneous tissue. There was a still further rise of 0°.05 C., during the last moments of life, and after death, the thermometer stood, 10 minutes after the cessation of the action of the heart, at 40°.6 C., 105°.1 F., in the rectum. At this time there is a strong peristaltic motion of the intestines. Temperature of surface of muscles, 36°.8 C., showing a fall in 10 minutes, of 1°.2 C. The temperature of the surface of the muscles commenced to sink immediately after the cessation of the respiration and of the pulsations of the heart. 20 minutes after the cessation of the action of respiration and circulation, temperature of rectum, 40°.56 C.; slight fall of 0°.04 C.; temperature of surface of muscles of limbs 35°.4 C., loss of 1°.4 C.

A powerful interrupted electro-magnetic current was then applied, 28 minutes after death, in various directions along the nervous centres; rigor-mortis had not as yet commenced. The muscles responded to the action of the electric currents, especially those of the head, ears and eyes, but to a much less degree than in animals killed by mechanical means, as when the medulla oblongata was severed. The currents were passed for several minutes through the entire length of the spinal cord, without any rise in the temperature of the rectum, and of the surface of the muscles. The effects upon the muscles of the extremities and trunk appeared to be less than upon the muscles of the face. 43 minutes after the cessation of the action of the heart, temperature of rectum, 39°.75 C.; of surface of muscles, 36°.; 173 minutes after cessation of heart, and 130 minutes after last observation, temperature of rectum, [illegible] C.; of surface of muscles, 33°.7 C.; 196, (23 after last observation), temperature of rectum, [illegible] C.; muscles, 33°.4 C.; temperature of atmosphere, 27° C.; 282 minutes, (186 after last observation), temperature of atmosphere, 26°.5 C.; of rectum, 34°.33 C.; of muscles, 32°.2 C.

Autopsy, 293 minutes after cessation of respiration and the action of the heart.

Rigor-mortis well marked. The blood corpuscles presented similar appearances as in the preceding case, some were a little swollen, others corrugated and stellated.

The brain and spinal cord presented no marked evidences of congestion. The base of the brain was more congested with blood than the superior portions. The microscopical examination of the structures of the brain, spinal cord and sympathetic, did not reveal any recognizable alterations or lesions. I could detect no alterations in the nerve cells or commissures of the cerebrum, cerebellum. pons varolii, medulla oblongata, or spinal cord and sympathetic, which would distinguish the action of strychnia from that of Prussic Acid. Lungs greatly congested; the liver, on the other hand, pale and bloodless. Stomach filled with digested matters, and presented a much redder appearance upon the exterior and interior than in the preceding experiment. Intestines, spleen, bladder and pancreas normal.

By a comparison of the preceding experiments, 148 and 149, it is evident that in one case the lungs were not congested, and in the other greatly congested, resembling liver in appearance, being heavy, and not collapsing; in one case the liver was greatly congested, in the other not at all; and in both the brain and spinal cord were free from congestion.

Experiment 150: Action of Acetate of Strychnia on Dog.

Augusta, Ga., March, 1860. Large dog (cross between Setter and Cur). Temperature of atmosphere 63° F.; of rectum 102° F. In this experiment, as in all others, recorded in this chapter, the carefully graded and accurate thermometer was allowed to remain in the rectum for 20 to 30 minutes, and until it ceased to rise for 5 or 10 minutes before the temperature was recorded.

Four grains of Acetate of Strychnia in solution, dissolved in a small quantity of water were injected into the sub-cutaneous tissue of the hind leg.

In six minutes, powerful tetanic spasms of the legs were produced, and during these the thermometer rose one degree F., to 103° F.

Fifteen minutes after the injection of the poison, breathing spasmodic; spasms of muscles, short, powerful and frequent. Temperature of rectum 103°.75 F.; one minute after this observation the breathing ceased entirely, whilst the heart continued to act slowly and spasmodically. Temperature of rectum 103°.75 F. The dog died 17 minutes after the injection of the Acetate of Strychnia. One minute after death the thermometer in the rectum showed a very slight fall, and stood at 103°.65 F.; six minutes after death, temperature of rectum 103°.5 F.; 19 minutes, 103°.5 F.; 21 minutes, 103°.5 F.; 28 minutes, 103°.5 F.; 42 minutes, 103°.33 F.; 52 minutes, 103° F.; 142 minutes, 99° F.; 202 minutes, 97° F.; 222 minutes, 95° F.; 248 minutes, 94° F. During the action of the strychnia, this dog was supported by strong assistants in the standing posture; after death it was hung up, to avoid all conduction of heat, and to allow the body to cool as in the preceding experiments by radiation; in all cases the animals being suspended horizontally, so as to occupy a standing position.

The urine passed during the last period of life, contained no traces of grape sugar.

Autopsy five hours after death. Blood presented a cherry red color, and coagulated and changed to arterial hue when exposed to atmosphere.

The blood was carefully examined before and after the injection of the Acetate of Strychnia, and after death; but nothing worthy of note was observed.

Membranes and structures of brain and spinal cord congested with blood to a greater extent than in the preceding experiments.

Experiment 151: Effects of Strychnia on large male Cat.

Solution of Acetate of Strychnia, injected sub-cutaneously. Powerful tetanic spasms commenced in 30 seconds after the injection, and the cat died in two minutes. Chloroform was administered by inhalation, a few minutes before death, but produced no permanent effects. Cadaveric rigidity occurred immediately after death, and the extremities were as "rigid as steel." One and a half minutes after death, the magneto-electric current, passed in every direction, produced no effects whatever on the muscular system. Blood drawn after death coagulated in 10 minutes.

Blood-vessels of brain filled with dark blood.

Experiments 152, 153, 154, 155, 156, 157, 158, 159, 160: Repetition of preceding Experiments with Strychnia on Mammalia. Results similar.

In these experiments the heart was exposed, and artificial respiration instituted, immediately upon the cessation of respiration and of the action of the heart. It was found to be impossible to excite the heart to action, either by artificial respiration or mechanical and electrical stimuli after death from Strychnia. In all cases the cavities of the heart were distended with black blood, when the thorax was opened and the organ exposed. This fact I have repeatedly demonstrated to my medical classes, viz: that Styrchnia acts directly upon the ganglionic centres and muscular structures of the heart, and so arrests the action of the sympathetic ganglia, that it is impossible to excite the action of the heart by any known means. The fact that interrupted electrical currents excited powerful spasmodic actions in the muscles supplied exclusively by the cerebro-spinal system, whilst they failed to stimulate the muscular structures of the heart, would seem to show that the nerves connecting the heart directly with the cerebro-spinal system are related to the ganglionic system proper of the heart, rather than to the muscular structures of the heart itself. In Strychnia poisoning the cessation of the action of the heart was not due either to the absence of oxygen from the blood, or to the accumulation of carbonic acid in this fluid; for in animals killed by division or injury of the medulla oblongata, the heart may be readily excited to contraction a considerable time after the cessation of its action, and when all its cavities are distended with black, venous blood, deficient in oxygen, and loaded with carbonic acid.

Dr. Charles Bland Radcliffe, in his "*Lectures on Epilepsy, Pain, Paralysis, and certain other disorders of the Nervous System.*"

> Affirms that there is reason to believe that one way in which Strychnia or Brucia, tends to bring about spasmodic muscular contraction, is by producing a change in the blood, which is equivalent to loss of arterial blood, p. 87.

Dr. Radcliffe supports this proposition by the following facts:

It has been shown by Dr. Harley (*Lancet*, 7th and 14th June, and 12th July, 1856,) that air which has remained for some time in contact with blood, to which Strychnia or Brucia has been added, contains more oxygen and less carbonic acid than air, which has been left in contact with simple blood, for the same length of time. It has been shown that blood poisoned in this manner respires less freely than pure blood. In one of the experiments by which this demonstration is effected, two tubes, similar in size and graduated upon the same scale, are filled half full of calf's blood. Then after adding a minute portion of Strychnia to the blood in one of the tubes, and after freely agitating the blood in each tube, with supplies of fresh air, both tubes are corked up and set aside, with the corks downwards. During the next twenty-four hours the blood and air thus corked up, are occasionally well shaken up together. At the end of this time the air which has been all this while in contact with the blood is analyzed by Bunsen's method; and it is found as is shown in the following table, that the air which has been in contact with the poisoned blood, contains more oxygen, and less carbonic acid than the air which has been in contact with simple blood.

GASES.	COMPOSITION OF COMMON AIR.	Composition of air after having been in contact with simple blood for twenty-four hours.	Composition of air after having been in contact with blood containing strychnia for twenty-four hours.
Oxygen	20.96	11.33	17.82
Carbonic Acid	.002	5.96	2.73
Nitrogen	79.038	82.71	79.45
	100.000	100,000	100,000

Dr. Radcliffe, from the results of these experiments, views the change wrought by Strychnia upon the blood, as equivalent to loss of blood:

> "For blood which cannot become arterial is as good as lost to all purposes of life. Nay, this change may be looked upon as equivalent to copious loss of blood; for in the experiment of which the results are given in the preceding table, a very minute quantity of the poison has had the effect of depriving the blood of full two-thirds of its natural power of becoming arterial. When Brucia was used in the place of Strychnia, the only difference was one of degree, the power of preventing the arterialization of the blood being somewhat less energetic in the case of Brucia, p. 89."

It is impossible to admit this explanation of the poisonous action of Strychnia, when we conceive how small a dose often produces fatal results, with astonishing rapidity.

Thus Dr. Warner, æt. 39, took by mistake, half a grain of sulphate of Strychnia; the symptoms began in less than five minutes, by constriction of the throat, tightness of the chest, and rigidity of the muscles, on attempting to move. He first complained of want of air, and requested the windows to be open. He died in from fourteen to twenty minutes, his mind remaining clear until the last. In the case of Mrs. S. Smyth, of Romney, three grains of Strychnia were taken by mistake for Salacine. This lady was in violent spasms, in from five to ten minutes afterwards, and she died in one hour and a quarter. A girl, æt. 13, took one grain and a half of Strychnia in solution on an empty stomach; the symptoms began by twitchings of the muscles, rather more than an hour after the poison was taken; and she died in a violent tetanic fit, in two hours after she had taken the poison. The sixteenth part of a grain of Strychnia, killed a child between two and a half and three years of age in four hours.

So powerful are the effects of this drug in certain cases that ordinary medicinal doses can scarcely be borne. Symptoms of its poisonous action have been frequently unexpectedly produced.

It is not necessary to assume any such explanation as that given by Dr. Radcliffe in the case of ordinary Traumatic Tetanus, which is closely related to Strychnia Tetanus, in the character and severity of the spasms, and in the rigid condition of the muscles, not only during the actual spasms, and also during the intervals between them. There are however, marked differences between the two states; ordinary tetanus commencing silently and progressing gradually as various segments of the spinal axis become involved, the expression of the countenance at the same time, being peculiar and characteristic; Strychnia Tetanus, on the other hand, is announced by violent general spasms, loud screams and moanings, and progresses rapidly to recovery or a fatal result. In both conditions there is exalted activity of the ganglionic cells of the spinal axis; in the former, this condition is gradually induced by the propagation of the excitation to different portions of the gray matter of the cord, and its prolongations; in the latter, the poison dissolved in the blood is carried to the ganglionic cells, and at once and directly excites their functional activity. These phenomena are far different from those induced by abstraction of blood, or by a deprivation of oxygen, or the accumulation of carbonic acid in the blood. That Strychnia acts directly upon a definite portion of the ganglionic matter of the cerebro-spinal axis is still further shown by the fact that whilst it increases the irritability of the spinal cord, it does not materially affect the functions of the brain; and its effects will show themselves without essential modification, after the head has been removed. Thus it has been observed by physiologists that if a decapitated frog be poisoned with a moderate dose of Strychnine, the body and limbs will remain quiescent as long as there is no external source of excitement; but the limbs are at once thrown into convulsions by the slightest irritation applied to the skin, as for example, the contact of a hair, or of a feather, or even the jarring of the table on which the animal is placed. The following fact first noticed by Bernard, has been adduced to show that the convulsions in cases of poisoning by Strychnia, are always of a reflex character and never spontaneous, viz: that if a frog be poisoned after division of the posterior roots of all the spinal nerves, while the anterior roots are left untouched, death takes place as usual, but is not preceded by any convulsions.

In this instance the convulsions are absent, simply because, owing to the division of the posterior roots, external irritations cannot be communicated to the cord. That strychnine in large and poisonous doses, acts directly upon the ganglionic cells, and not indirectly by causing congestion of the blood-vessels is shown by the interesting fact observed in the preceding experiments, and in those performed by Dr. R. B. Todd, that in rapid poisoning by Strychnia, however great the excitement may have been into which the cord has been thrown by Strychnine, it exhibits no change of structure which can be detected by the microscope. The experiments of Professor Schroeder Van Der Kolk, to which I have referred in the first chapter of these Medical Memoirs, on the contrary, appear to establish the fact that Strychnia may cause congestions of certain portions of the spinal cord. Thus he says:

> "There has been a great deal of controversy, as to whether the gray matter of the antero-lateral or posterior columns are at all sensitive or not, and on this subject the most conflicting opinions have been broached, which are stated by Volkmann in a short review. Nerven Phys. l. c. p. 548.
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> "In my opinion the gray matter in the spinal cord serves solely for motion, the posterior rather for reflex action and the coördination of movement, while sensation is transmitted

> upwards exclusively through the posterior and lateral medullary columns. That such is the case, I inferred especially from the phenomena produced by strychnia in a dog: in slighter attacks the hind feet acted first, and subsequently continued more rigid, the animal standing upon them with the body inclined obliquely forward. Not only during these convulsions, but even when the animal lay more than once upon the ground, with its feet stretched out in tetanic rigidity, it had not lost consciousness of which my audience were witness with me; thus, when a white cloth was accidentally drawn from one side of the apartment to the other, the dog followed it with his eyes and head, while it appeared from all that occurred, that he did not experience the least pain. We also know, that after excessive doses of strychnia the patients, without feeling anything, are suddenly seized with abnormal movements and convulsions. After the death of the dog, I examined the spinal cord and brain chiefly with the view to discover any congestion which might have existed in the several parts; in the brain I met no unusual degree of congestion, but I was particularly struck with a remarkable condition of the gray matter of the lumbar bulb; it presented in fact, numerous small effusions of blood, (*See also Ecker*, *Diss. land*, pp. 119, et seq.,) while in the medullary portion no abnormality was found. In another dog killed under the influence of strychnia, I found in the gray matter of the lumbar portion, aneurismal dilatation of the capillary vessels, which were in consequence on the verge of bursting. Perhaps similar effusions had taken place, but in the sections I prepared I had not met with them. In both cases, however, the two horns of gray matter were most beautifully injected with blood, as was evident after the sections were dried and placed in Canada balsam·
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> "Hence, it would appear, that after the administration of strychnia, great congestion and irritation take place in the gray matter, which in the situation where they are most fully developed as in the loins, may pass into effusion or dilatation of the blood-vessels, and still all this occurs without any sensation, without any pain. Were the gray matter in the spinal cord sensitive, or did the sensitive nerves penetrate into the gray matter, such congestion and irritation as excites in a sensitive nerve itself the most intense pain, could not be conceived to exist without occasioning some sensation. Hence, it follows also, that reflex movements cause no pain nor sensation in the spinal cord, so that by this observation, the direct ascent of the sensitive nerves in the spinal cord,—of which I possess the most satisfactory preparations, is physiologically or pathologically, if we will, confirmed." *Minute Structure and Functions of the Spinal Cord*, pp. 77–79.

The accuracy of the observations of Professor Schroeder Van Der Kolk, cannot be questioned, especially too as his observations are accompanied by a drawing of the section of the spinal cord of one of the dogs poisoned by strychnia, displaying the dilated and aneurismal capillaries and the circumscribed effusions.

As far as my observations extend, such changes are not uniformly present in the spinal cord of dogs killed by large doses of strychnia in a short time, and I have been led to refer the violent tetanic spasms to the direct action of the poison upon the ganglionic cells, rather than to congestion of the blood-vessels, which without doubt may favor and promote convulsive action; but rarely produce such violent tetanic spasms as result in death in the course of a few minutes.

Dr. Todd has recorded the observation, that opium has the effect of causing a similar state of polarity of the cord, which is most conspicuous in cold-blooded animals; and hence, he concludes, that opium should not be used in large doses, in cases of Tetanus; and experience has shown the inefficiency and the injurious influence of this drug when administered in large quantities.

A similar objection may be urged against Hydrocyanic Acid in the treatment of Traumatic Tetanus, for it not only in large doses excites the reflex power of the spinal cord and produces violent spasms, especially of the respiratory muscles, but it alters injuriously the blood and destroys the power of the heart. In such cases of spasmodic disease, Conium and Belladonna have been found to exercise beneficial effects as sedatives.

Dr. R. B. Todd ascertained by several experiments, such as the following, that the inhalation of Ether, has considerable effect in controlling the natural polar state of the cord, as well as that which may be produced by Strychnine. A pigeon deprived of its cerebral hemispheres, lives in a state of sleep for a considerable time; it flies when thrown into the air, spreading and flapping its wings; standing when placed on its feet. A bird thus mutilated, was made to inhale Ether; it could not stand, and when thrown into the air, it fell to the ground like a heavy log, its wings remaining applied to the sides of its body, or if the wings were drawn out, as it was thrown into the air, they quickly collapsed. As soon as the effects of the Ether had passed off, it stood and flew as before. Dr. Todd gave Strychnine to a rabbit, a Guinea-pig, and a dog, so as to excite the tetanoid state. Immediately the spasms showed themselves. Dr. Todd brought it under the influence of Ether, the spasms ceased immediately, and the animal became perfectly relaxed; but as soon as the effects of the Ether passed off, the spasms came on again; but were soon subdued by a fresh inhalation of Ether. And thus, Dr. Todd found that the life of an animal, poisoned by Strychnine, could be greatly prolonged through successive inhalations of Ether; for animals of the same kind, poisoned by equal doses of Strychnine, but not subjected to the influence of Ether perished very rapidly. (Cyclopædia of Anatomy and Physiology, vol. iii, p. 721).

Dr. Samuel Jackson, of Philadelphia, informed me that in a series of experiments which he instituted some twenty years ago, upon digestion, Strychnine was the agent employed to cause death, and when Chloroform was administered by inhalation, the effects of the Strychnine on the animals, was not only relieved temporarily, but in several instances the dogs survived the action of the poison.

I have repeated these experiments of Drs. Todd and Jackson, on the effects of Ether and Chloroform in poisoning by Strychnia; and have obtained similar results, and these must be looked on as the most valuable agents in the treatment of poisoning by Strychnia, as well as of Traumatic Tetanus.

COMPARATIVE EXPERIMENTS ON THE ACTION OF POISONS, AND THE DIVISION OF THE MEDULLA OBLONGATA, 1860, 1861.

Experiment 161: Action of Strychnine on Warm-Blooded Animals.

Large, powerful, female Bull Dog. 4 grains of Acetate of Strychnia in solution of excess of Acetic Acid, were injected beneath the skin of the thigh; symptoms of poisoning were manifested in three minutes. The animal showed no pain or uneasiness, until a slight spasm came on, and succeeded by spasms increasing in violence and duration. These spasms were separated by intervals of quiet and relaxation. During these intervals, the spasms might at any time be excited by striking or touching the body with the hand. The spasms became exceedingly violent, and when the thorax was struck, it sounded like a wooden cylinder, and the muscles felt as hard as steel: at such times it was impossible to feel the vibrations of the heart.

The pupils were at one time much dilated and then became contracted. Death took place in seven and a half minutes. The respiration ceased before the action of the heart. After death, and at the moment of death, the muscles were relaxed, the mouth could be readily opened, and the limbs could be moved in every direction; cadaveric rigidity came on, 30 minutes after death. The moment that the heart had ceased beating, the thorax was opened, and the heart was found distended with blood. When the heart was pricked with the point of a scalpel, not the slightest contraction was observed; handling the heart produced no effect whatever on its fibres. Artificial respiration was immediately instituted on opening the chest; this had no effect whatever, on the heart, it remained perfectly still.

Interrupted galvano-electric currents were passed through the heart and the nerves supplying it; but in like manner, no effect was produced upon the heart; the auricles and ventricles remained entirely unmoved; no contractions were observed in the muscular fibres.

The electrical currents, on the other hand, excited marked contractions in the diaphragm, thoracic muscles, and, in fact, in all the voluntary muscles of the body.

The peristaltic motion of the intestines had nearly ceased, and the electrical current produced but little effect upon the intestines—it excited some movement, but it was feeble and of short duration. The poison had evidently acted upon the intestines as well as upon the heart; either upon the sympathetic system, or upon the unstriped muscular fibres.

It is evident that the Strychnine acted directly on the gray matter of the spinal cord, because the tetanic spasms were simultaneous and universal in all the voluntary muscles, and a single touch was sufficient to excite tetanic spasms in all the muscles.

Effects on the temperature.—Temperature of rectum previous to the injection of Acetate of Strychnia, 39°.9 C., 103°.8 F.; during the violent spasms excited by the Strychnine, the temperature rose slightly, and stood at 40° C., 104° F. at the moment of death. Temperature of rectum 80 minutes after death, 38°.5 C.; 3 hours after death, 34°.3 C.; 5 hours after death, 29°.8 C. Temperature of atmosphere, 58° F.

The artificial respiration was attended with cooling of the body, which took place more rapidly than in those animals thus poisoned, in whom no artificial respiration had been performed.

Experiment 162: Action of Prussic Acid on Warm-Blooded Animals, performed pari passu with the preceding.

Three fluiddrachms of officinal solution of Hydrocyanic Acid were injected into the subcutaneous tissue of the back of a large, strong dog.

Three minutes elapsed before any symptoms of poisoning were manifested; then followed convulsions, death-cry, or loud, distressed bark, long-drawn, gasping respiration, feeble action of the heart, occasional spasms of the muscles, and death in 10 minutes.

The thorax was opened immediately; there was a fibrillary motion or contraction about the ventricles and auricles, which were distended with black, venous blood.

Artificial respiration was instituted; the action of the heart was very slightly increased, especially that of the auricles; the interrupted galvano-electric current was also passed through the heart; it produced a very slight increase in the feeble "flickering" motion. The diaphragm and respiratory muscles contracted under the action of the electrical stimulus. Although the heart continued to tremble or contract feebly under the artificial respiration, still its action was exceedingly feeble, and in fact, its pulsations could hardly be considered as anything more than vibratory motions of some of the muscular bundles. The peristaltic motions of the intestines were very feeble. When the experiment was repeated in other dogs, no action whatever was observed in the heart or intestines, and could not be excited by mechanical or electrical stimuli.

Experiment 163: Division of the Medulla Oblongata near the base of the Fourth Ventricle: Large, powerful Bull Dog,

When the blade of the scalpel swept through the medulla oblongata, respiration ceased immediately; the intervertebral arteries were cut, and profuse hæmorrhage took place.

Thorax opened 8 minutes after death, and several minutes later than in the preceding experiments. The heart, which was apparently quiescent, commenced to pulsate as soon as it was touched with the point of the scalpel. Artificial respiration produced a full and strong pulsation. The electrical excitement produced strong and full contractions of the auricles and ventricles. The heart continued to beat with regularity and vigor for near one hour, during the continuance of the artificial respiration.

When the intestines were touched with the point of a scalpel, the peristaltic motion was excited vigorously; the electro-magnetic currents accomplished the same effects.

The interrupted electric currents produced powerful effects upon the voluntary muscles. The diaphragm and respiratory muscles, and in fact, all the muscles, contracted with the greatest violence; the limbs were thrown into the most violent contractions, also the muscles of the face, and when the current was passed throughout the length of the spine, the most violent contractions of all the muscles were excited.

The vigorous action of the heart, and the violent muscular motions, were in most striking contrast with those of the dogs poisoned with Strychnine and Prussic Acid.

Effects on Temperature.—Temperature of rectum previous to destruction of medulla oblongata, 40°.33 C. Temperature of atmosphere, 58° F. Temperature of rectum 30 minutes after cutting medulla oblongata, 39°.9 C.; two hours afterwards, 35°.45 C.; four hours, 30°.55 C.

In the dog killed by Strychnine, the brain was pale, and not at all congested; in the dog killed by Prussic Acid, the blood-vessels were fuller, but not congested to a great extent; whilst the brain of the dog which had been pithed was more congested than in the former cases. The spinal cord was not specially congested in the three dogs; and microscopical examination of the nervous structures revealed no characteristic alteration which could be referred to the action of the poisons.

The heart was distended with dark blood, and its muscular structures were flabby and relaxed in the dogs killed by Prussic Acid and Strychnine, whilst it was small, contracted and firm in the dog killed by mechanical means. The liver, in the dogs killed by Prussic Acid and Strychnine was greatly congested. The blood-vessels of the intestines were also congested and distended with dark blood, whilst they were not congested in the dog destroyed by pithing.

Experiments 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178: Repetition of preceding Experiments (161, 162, 163), with similar results.

Experiments 179, 180, 181, 182, 183, 184, 185: Repetitions of the experiments on the action of Binoxide. Peroxide of Nitrogen and Chlorine Gas, on Mammalia, illustrating the stimulant effect of these gases, and especially of the latter, and establishing the great value of Chlorine as an Antidote to the poisonous effects of Hydrocyanic Acid.

The symptoms of poisoning by Prussic Acid, described in the preceding experiments, on animals, are similar to those which have been observed in human beings. Böcker considers that there are three stages in the symptoms of poisoning by Prussic Acid, when the dose of the diluted acid is small, but at the same time sufficient to destroy life: First, a sense of constriction in the chest—convulsive breathing, with distortion of the features, giddiness, the eyes fixed, projecting and starting, oppression at the heart; second, convulsions, with opisthotonos, spasm of the larynx, of the urinary bladder, loud cries, involuntary discharge of urine and fæces, loss of consciousness; third, general paralysis, pulselessness, coma, relaxation of the muscles, general cessation of respiration and pulsation of the heart, greatly dilated pupils, flow of frothy saliva, and death in from half an hour to one hour. In man, the symptoms follow each other with great rapidity, or the third stage rapidly supervenes upon the first.

According to Taylor, when a large dose has been taken, as from half an ounce to an ounce Scheele's Acid, the symptoms may commence during the act of swallowing, or within a few seconds. It is rare that their appearance is delayed beyond one or two minutes. When the patient has been seen at this period, he has been perfectly insensible the eyes fixed, prominent and glistening, the pupils dilated and unaffected by light, the limbs flaccid, the jaws fixed, frothing at the mouth, the skin cold, and covered with a clammy perspiration; there is convulsive respiration at long intervals, and the patient appears dead; in the intermediate time, the pulse is imperceptible; and involuntary evacuations are occasionally passed. The respiration is slow, deep, gasping, and sometimes heaving, sobbing or convulsive When a small dose (i. e. about thirty drops of a weak acid) has been taken, the individual has first experienced weight and pain in the head, with confusion of intellect, giddiness, nausea, a quick pulse, loss of muscular power, shortness of breathing and palpitation; these symptoms are sometimes slow in appearing. An increased flow of saliva, as well as vomiting, has been occasionally amongst the symptoms when the acid was much diluted, but it is more common to find foaming or frothing at the mouth, with suffusion, or bloated appearance of the face, prominence of the eyes. If death results, this may be preceded by tetanic spasms, opisthotonos, and involuntary evacuations. Vomiting is sometimes the precursor of recovery.

As in the case of animals, so also, with men, the action of Hydrocyanic Acid resembles, to a certain extent, that of Strychnine; but it also exerts a decided effect on the heart, not only by rendering its contractions irregular, and causing in the arterial system, variations of pressure, but also by its direct action on the ganglionic cells.

The following conclusions may be drawn from the preceding experiments with Hydrocyanic Acid, Cyanide of Potassium and Strychnine on warm-blooded animals.

GENERAL CONCLUSIONS AS TO THE NATURE OF THE EFFECTS OF CERTAIN POISONS, AS HYDROCYANIC ACID, CYANIDE OF POTASSIUM AND STRYCHNINE.

I. After the introduction of these poisons into the sub-cutaneous tissue, or after their application to the tongue and mucous membrane of the stomach, a certain period of time elapses before the manifestation of the symptoms of poisoning; and during this period the poison is absorbed, mingles with the blood, and is distributed to the various organs and tissues, and is thus brought into contact with the ganglionic cells of the cerebro-spinal system.

Various statements have been made as to the rapidity of the effects of Prussic Acid in producing poisonous symptoms and destroying life, which have not been sustained by the preceding experiments. In the most suddenly fatal cases, the action has been referred by some physiologists, to nervous action transmitted from the points at which the poison touched the extremities of the nerves. The incorrectness of this view has been shown by experiments, similar to the following performed by Blake. The portal vessels of an animal being tied, seven fluiddrachms of Scheele's Acid were introduced into the stomach on the "*sentient extremities*" of the nerves on which the poison is said to act. Ten minutes elapsed without the slightest effect; the ligature was removed, and one minute afterwards, the effects of the poison manifested themselves. It is evident that those who give this explanation of the sudden effects of Prussic Acid, leave entirely out of view, the fact that Hydrocyanic Acid is highly volatile, and that if a drop of the pure acid be approached towards the tongue of a living animal, the acid evaporates and reaches the lungs by inhalation, and is immediately diffused over an immense absorbent surface, before the drop of acid actually reaches the mucous membrane of the mouth. It is well known that Prussic Acid is most rapidly fatal in the form of vapor; and I have been myself upon more than one occasion most seriously affected by the vapors of the acid during my experiments. The time of the action of the poison should be reckoned from the moment that its vapor reaches the capillaries of the lungs, and the place of action should be considered the extensive absorbent surface of the bronchial tubes, and air cells; now it is well established that the poison may reach the heart and cerebro-spinal and sympathetic systems in an almost inconceivable short space of time from the lungs. That a sufficient interval elapses between the application of the acid and the moment when its first effects are produced, to allow of its being brought into contact with the central ganglionic masses, will be evident from the consideration of the following facts:

Haller and Sauvages were the first who tried to ascertain by experiment, with what velocity the blood is carried through the vascular system; their calculations however, were erroneous, as they were founded upon the supposition that the movement of the blood depended exclusively upon the action of the heart. Haller's conclusions respecting the velocity of the circulation in frogs and small fish, are more correct, as they were confirmed by autopsies; but his observations were confined to cold-blooded animals, and it is scarcely necessary to mention how hazardous it would be to infer from them the velocity of the blood in warm-blooded animals. The same remark applies to the experiments of Spallanzani and Dollinger. In more recent works on the subject, the comparison of the quantity of blood contained in the ventricles of the heart, with the whole mass of the blood, and with the number of pulsations in a certain time, was considered sufficient to determine the relative velocity of the blood; a method, the uncertainty of which clearly appears from the circumstance, that the quantity of blood cannot be made out with precision, and that the number of pulsations and the capacity of the ventricles differ very considerably in different individuals. Mr. Hering of Stittgart, found the capacity of the left ventricle in horses, differing from 3 to 11 ounces, and that of the right ventricle from 4 to 38 ounces.

M. Hering tried another method which seems to lead to more accurate results. He mixed a solution of the Cyanide of Potassium with the blood; he then took at certain intervals, small quantities of blood from various parts of the body; and from the chemical examination of these different portions of blood, and from the comparison of the time which the substance required to arrive from one vessel into another, endeavored to ascertain the relative velocity of the blood. The experiments were performed upon horses, and the following are the conclusions arrived at by Mr. Hering.

1st. The time within which the Cyanide of Potassium after having been mixed with the blood, passes from one of the jugular veins into the opposite, is from twenty to thirty seconds; from the jugular vein into the thoracica externa, twenty-three to thirty seconds; into the saphen magna, twenty seconds; into the arteria mesenterica, fifteen to thirty seconds; into the arteria maxilla externa of the opposite side, from ten to twenty-five seconds; and into the arteria metatarsi, from twenty to forty seconds.

2. The Cyanide of Potassium, within a very short time after its introduction into

the blood is excreted by the serous membranes, but in small quantity. The time varies from two to eight minutes.

3. In the kidneys the excretion appears to take place with the greatest rapidity; in all experiments, within one minute after the introduction into the blood, the Cyanide of Potassium was found in the cortical, sometimes also in the tubular substance, and in a few instances in the pelvis of the kidneys.

4. Only one minute is required to bring the substance from the jugular vein into the thoracic duct.

II. Prussic Acid produces no absolutely uniform alterations in the circulation of the cerebro-spinal system, recognizable after death; and the cerebral and reflex symptoms are not due to the engorgement of the blood-vessels. In some cases, the brain was not at all congested, in others the veins were distended with blood; and the blood after 15 hours showed a great tendency to transude through the coats of the vessels from its disorganization, and thus inducing a much greater appearance of congestion and irritation than actually existed at the moment of death.

The symptoms of cerebral disturbance—delirium, coma, expansion of the pupil, were as strongly marked in the cases in which the brain was not specially congested, as in the cases in which it was most congested. Independent of those facts, it is evident that the mere state of engorgement of the blood-vessels could not produce death in so short a time. In some cases the spinal cord was not specially congested; in others the veins were distended with blood, and in others still, both the veins and arteries were filled with blood. Violent spasms, opisthotonos and all the phenomena of aberrated spinal action were as well marked in one condition of the spinal cord, as in the other. We are compelled from these facts, to conclude, that Hydrocyanic Acid produces no absolutely uniform alterations in the circulation of the spinal cord recognizable after death; and that the aberrated muscular actions are not due to the engorgement of the blood-vessels of the spinal cord and its membranes. Independently of the fact stated above, it is evident that the mere state of engorgement of the vessels of the spine, could not produce death in so short a time. Careful microscopical examinations did not reveal any uniform alterations in the nervous elements.

III. The peculiar phenomena manifested by the cerebro-spinal nervous system, in poisoning by Hydrocyanic Acid, are due to the action of the poison on the nervous elements conveyed to them by the blood; to the action of the altered blood on the nervous elements, and sudden arrest of the capillary circulation of the cerebro-spinal nerves, in consequence of the action of the poison on the sympathetic nervous system, and muscles and ganglia of the heart; to the reflex action of the sympathetic system, and to the complicated actions and reactions of the poison on the individual structures.

IV. In poisoning by Prussic Acid, the disturbances of the sympathetic nervous system are not less marked than those of the cerebro-spinal nervous system. The slow, full respiration, the slow action of the heart in some cases, and its feeble rapid action in others, the feeble pulse, the diminution of temperature in the extremities, the rise of temperature in the trunk during the first stages of the action of the poison—the subsequent fall in the temperature of the trunk before death in some cases—the accumulation of the blood in the large veins of all the organs and tissues, in most cases of poisoning by Hydrocyanic Acid—the engorgement of the veins of the stomach, small intestines, spleen, liver and kidneys;—the suppression of urine in some cases, all point to aberrated nervous action of the sympathetic system.

The mere congestion of the blood-vessels of the sympathetic nervous system, could not account for any one of these phenomena—in fact, if the sympathetic nervous system presides more especially over the circulation, the stagnation of the blood in the vessels of the sympathetic, and in fact in the blood-vessels of the cerebro-spinal nervous system, and of all the organs and tissues, is evidently the effect, rather than the cause of the aberrated sympathetic nervous phenomena.

From these facts it appears to be proper, to conclude, that the aberrated nervous rectum 80 minutes after death, 38°.5 C.; 3 hours after death, 34°.3 C.; 5 hours after death, 29°.8 C. Temperature of atmosphere, 58° F.

The artificial respiration was attended with cooling of the body, which took place more rapidly than in those animals thus poisoned, in whom no artificial respiration had been performed.

Experiment 162: Action of Prussic Acid on Warm-Blooded Animals, performed pari passu with the preceding.

Three fluiddrachms of officinal solution of Hydrocyanic Acid were injected into the subcutaneous tissue of the back of a large, strong dog.

Three minutes elapsed before any symptoms of poisoning were manifested; then followed convulsions, death-cry, or loud, distressed bark, long-drawn, gasping respiration, feeble action of the heart, occasional spasms of the muscles, and death in 10 minutes.

The thorax was opened immediately; there was a fibrillary motion or contraction about the ventricles and auricles, which were distended with black, venous blood.

Artificial respiration was instituted; the action of the heart was very slightly increased, especially that of the auricles; the interrupted galvano-electric current was also passed through the heart; it produced a very slight increase in the feeble "flickering" motions. The diaphragm and respiratory muscles contracted under the action of the electrical stimulus. Although the heart continued to tremble or contract feebly under the artificial respiration, still its action was exceedingly feeble, and in fact, its pulsations could hardly be considered as anything more than vibratory motions of some of the muscular bundles. The peristaltic motions of the intestines were very feeble. When the experiment was repeated in other dogs, no action whatever was observed in the heart or intestines, and could not be excited by mechanical or electrical stimuli.

Experiment 163: Division of the Medulla Oblongata near the base of the Fourth Ventricle: Large, powerful Bull Dog,

When the blade of the scalpel swept through the medulla oblongata, respiration ceased immediately; the intervertebral arteries were cut, and profuse hæmorrhage took place.

Thorax opened 8 minutes after death, and several minutes later than in the preceding experiments. The heart, which was apparently quiescent, commenced to pulsate as soon as it was touched with the point of the scalpel. Artificial respiration produced a full and strong pulsation. The electrical excitement produced strong and full contractions of the auricles and ventricles. The heart continued to beat with regularity and vigor for near one hour, during the continuance of the artificial respiration.

When the intestines were touched with the point of a scalpel, the peristaltic motion was excited vigorously; the electro-magnetic currents accomplished the same effects.

The interrupted electric currents produced powerful effects upon the voluntary muscles. The diaphragm and respiratory muscles, and in fact, all the muscles, contracted with the greatest violence; the limbs were thrown into the most violent contractions, also the muscles of the face, and when the current was passed throughout the length of the spine, the most violent contractions of all the muscles were excited.

The vigorous action of the heart, and the violent muscular motions, were in most striking contrast with those of the dogs poisoned with Strychnine and Prussic Acid.

Effects on Temperature.—Temperature of rectum previous to destruction of medulla oblongata, 40°.33 C. Temperature of atmosphere, 58° F. Temperature of rectum 30 minutes after cutting medulla oblongata, 39°.9 C.; two hours afterwards, 35°.45 C.; four hours, 30°.55 C.

In the dog killed by Strychnine, the brain was pale, and not at all congested; in the dog killed by Prussic Acid, the blood-vessels were fuller, but not congested to a great extent; whilst the brain of the dog which had been pithed was more congested than in the former cases. The spinal cord was not specially congested in the three dogs; and microscopical examination of the nervous structures revealed no characteristic alteration which could be referred to the action of the poisons.

The heart was distended with dark blood, and its muscular structures were flabby and relaxed in the dogs killed by Prussic Acid and Strychnine, whilst it was small, contracted and firm in the dog killed by mechanical means. The liver, in the dogs killed by Prussic Acid and Strychnine was greatly congested. The blood-vessels of the intestines were also congested and distended with dark blood, whilst they were not congested in the dog destroyed by pithing.

Experiments 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178: Repetition of preceding Experiments (161, 162, 163), with similar results.

ganglionic cells of the spinal axis, and that if the irritation be continued for a sufficient length of time, structural alterations of the spinal axis are established.

XV. Traumatic Tetanus, although influenced in its origin and progress by external circumstances, and the state of the system at the time of the reception of the injury, is not caused by the generation within the system of a poison, which acts like Strychnine, or Prussic Acid, or Woorara.

This conclusion will be still farther illustrated by the following tabular comparison of the symptoms of Tetanus, Hydrophobia, Woorara, Strychnine and Prussic Acid Poisoning.

Tabular view of the Symptoms of Tetanus and Hydrophobia, and of the Poisonous effects of Syrychnine, Woorara, and Hydrocyanic Acid.

TETANUS.	HYDROPHOBIA.	POISONING BY STRYCHNIA.	POISONING BY WOORARA.	POISONING BY HYDROCYANIC ACID.
Cause. Rarely from exposure to cold, and rarely from bite of animal. Most generally caused by mechanical injury of nerve. Symptoms occur soon after injury, most generally within 12 days.	*Cause.* Bite of a rabid animal. Hydrophobia rarely appears before the thirtieth day, and months may elapse before the reception of the injury and the appearance of the symptoms.	After the administration of the poison, after an interval varying from a few minutes to one hour and even longer, and sometimes without any premonitory symptoms, the person is suddenly seized with a feeling of suffocation and great difficulty of breathing. There are twitchings and jerkings of the head and limbs, and a shuddering or trembling of the whole frame. Tetanic convulsions then commence with great violence, and nearly all the muscles of the body are suddenly and simultaneously affected. The limbs are stretched out; the hands are clenched; the head, after some convulsive jerkings, is bent backwards; the whole body is as stiff as a board, and assumes by increase of the convulsions, a bow-like form (opisthotonos), being arched in the back and resting upon the head and heels. During the fit, the head is forcibly bent backwards, and the soles of the feet are incurvated or arched, and everted. The abdomen is hard and tense—the chest spasmodically fixed, so that respiration appears to be arrested; the face assumes a dusky or congested appearance, with a drawn or anxious expression; the eyeballs are prominent and straining, and the lips are livid. The features have been observed to assume the peculiar appearance given by the sardonic grin. (*Risus Sardonicus*). The patient complains of a choking sensation, with dryness of the throat. An attempt to drink is often accompanied with a spasmodic closure of the jaws, by which the glass or vessel is broken or bitten. The intellect is generally clear or unclouded, during the intervals of the paroxisms, and the patient appears to have a full sense of his danger. After a succession of fits, and generally shortly before death, there may be a loss of consciousness.	Active when introduced into a wound, but almost inert when taken into the stomach. Acts with great rapidity after its introduction. The symptoms which it produces in animals are stupor and paralysis. It does not begin to produce any apparent effects, until after a lapse of one or two minutes, and there is apparently no pain; convulsions come on in two or three minutes, and the animal dies in four or five minutes. Small animals are killed in a few minutes; when the poison is injected into a wound, they loose all power over the muscles, become insensible, and die without convulsion. In one experiment, three arrows were introduced beneath the skin of an ox; for four minutes there was no effect; the animal then set itself firmly on its four legs, as if to resist falling, and remained quite still for fourteen minutes. It then attempted to walk, staggered and fell; the eyes became fixed, dim, and apparently insensible to light. Convulsions appeared in the legs, there was emprosthotonos, laborious respiration, and an escape of frothy liquid from the mouth. The convulsions in the extremities gradually ceased; there was still a perceptible action of the heart at intervals. In twenty-five minutes the animal was quite dead. Woorara appears to scarcely affect the spinal marrow, but it paralyses the voluntary muscles.	The time at which the symptoms of poisoning by Prussic Acid commence, varies within narrow limits: but is generally within a few minutes after the poison has been swallowed. When a large dose has been taken, as from half an ounce, to an ounce of the diluted acid, the symptoms usually commence in the act of swallowing, or within a few seconds. It is rare that their appearance is delayed beyond one or two minutes. When the patient has been seen at this period, he has been perfectly insensible, the eye fixed and glistening, the pupils dilated and unaffected by the light, the limbs flaccid, the skin cold and covered with a clammy perspiration; there is convulsive breathing at long intervals, and the patient appears dead in the intermediate periods; the pulse is inperceptible, and involuntary evacuations are occasionally passed. The respiration is slow, deep, gasping, and occasionally heaving and sobbing. It is generally convulsive, but when the coma, or insensibility is profound, it may be stertorous. The vapor of anhydrous Prussic Acid, if rarified, would prove almost instantaneously mortal. Even the vapor of the diluted acid occasions when inspired, immediate dizziness, stupor, loss of muscular power and faintness. Convulsions of the limbs and trunk, with spasmodic closure of the jaws, are usually met with among the symptoms; the finger nails have been found of a livid color, and the hands firmly clenched. Prussic Acid acts primarily on the medulla oblongata, and arrests the respiration, and hence, the sense of constriction about the chest, and the spasmodic breathing. Where the dose of the diluted acid is small, there appears to be three stages: 1st. Sense of constriction of the chest,
Progress of Symptoms.	*Progress of Symptoms.*			
The irritation is transmitted along the injured nerves to the spinal axis, inducing a state of congestion, excitement and exalted action of the ganglionic cells, and more especially of those related to the reflex function. Spasms of muscles more continued; less remitting and never intermitting. Constant rigidity of the jaw, becoming gradually fixed and closed: tonic spasms.	Spasm of muscles of brief duration; marked intervals of rest and quiescence between the spasms. During the intervals of rest and quietude, the jaw relaxes and opens and shuts readily. The Spasms are Clonic.			
The bite of a tetanic animal or patient does not produce tetanus.	The disease invariably communicated by the bite of Hydrophobic animals.			
Countenance altered by contraction of muscles; drawing up of nose, wrinkling of forehead; angles of mouth drawn towards cheek bone, presenting the tetanic countenance and Risus Sardonicus. There is an expression of pain but the eyes are natural.	Expression of countenance, that of excitement, fearful distress and peculiar restlessness, eyes bright and glistening, but at times suffused. Occasionally the countenance is frightfully convulsed.			
No great thirst, and in general, no great aversion to fluids administered in small quantities; rarely any discharge of Saliva.	Thirst, but at the same time aversion to fluids; even the sight or noise of fluids, induces paroxysms. Frequent and viscid discharges of Saliva, efforts to disengage it, inducing vomiting and barking.			

Bowels obstinately constipated, but vomiting and gastric pains rare.	Vomiting and gastric pains general.	The muscles of the lower jaw which are generally the first to be affected in tetanus, are generally the last to be affected by Strychnine.	Its effect is to destroy the motor power of the nervous system, and its action is the very reverse of that of strychnia.	convulsive breathing, with distortion of the features, giddiness, the eyes fixed, projecting and staring, oppression at the heart; 2d. Convulsions with opisthotonos, spasm of the larynx, and of the Urinary bladder, loud cries, involuntary discharges of urine and fæces, loss of consciousness; 3d. A general paralysis, pulselessness, coma, relaxation of the muscles, gradual cessation of respiration and prostration of the heart, greatly dilated pupils, flow of frothy mucus and death in from half an hour to one hour. Prussic Acid acts upon the brain, medulla oblongata, spinal cord, sympathetic ganglia, and on the Heart and Blood.
As a general rule, temperature but slightly elevated: in some cases remarkable rise of temperature (115° F.) before death.	Intolerant sensibility of surface and organs of sense.	The jaw is not primarily attacked, and is not always fixed during the paroxysm. It is relaxed in the interval, and the patient can frequently speak and swallow.		
As a general rule, patient confined to bed, from persistent contraction of muscles of body, (Opisthotonos) emprosthotonos, pleurosthotonus.	As a general rule, patient not confined to bed, walks about between the paroxysms.	When the jaw has been fixed by spasm, unlike the lock-jaw of tetanus, this has come on suddenly and in full intensity, with tetanic spasms in other parts, and there are intermissions which are not witnessed in Traumatic and Idiopathic Tetanus.		
Mind generally clear to last.	Mind subject to rabid impulses, and numberless deviations passing to delirium. Brain as well as medulla oblongata involved.	In Strychnine poisoning the duration of the case, is measured by minutes; and in Tetanus on the other hand, by hours and days.		
Mortality heavy, but recovery in both Idiopathic and Traumatic Tetanus.	No authentic case of recovery.	The heart loses its power in Strychnine poisoning, and death may result from this cause, as well as from spasm of the respiratory muscles. The temperature may be slightly increased during the muscular spasms, but declines during the intermissions, and there is no rise of temperature preceding death. In both Strychnine Poisoning and Tetanus, the reflex function of the spinal cord is greatly exalted.		

XVI. In the experiments on the action of Prussic Acid and Strychnine
mortem elevations of temperature were observed. This point is of inter
bearing on the action of certain poisons.

The interesting and singular fact discovered by De Haen, of Vienna,
year 1760, that the temperature of the body may rise after death, was lost fo
century, until it was revived by Royer, and Dr. Bennett Dowler, the dist
Physiologist of New Orleans, Louisiana, and carefully investigated by W
Adolph Valentine has recently endeavored to show, that the occurrence of post
heat is common to all dead bodies, the difference being only in degree. As f
subject has been investigated, it appears that the heat is most quickly and deter
developed after death, from rapid injuries and lesions of the nervous cent
especially of the brain. Thus, in Cerebro-Spinal Meningitis, the temperatu
death, has risen from 104° to 111° F. In Cholera, Huckkenet observed th
mometer to rise from 79° to 92° F. after death; in Variola, attended with muc
rium, Simon observed a rise of temperature form 104° F. at death, to 1
afterwards.

No elevations of temperature on the other hand have been observed after de
near three hundred animals which I have destroyed in various ways, but chie
violent poisons.

CHAPTER V.

TREATMENT OF TRAUMATIC TETANUS.

Treatment of Traumatic Tetanus. Historical Notes on the Treatment, illustrating the methods advocated by Hippocrates, Aretæus, Galen, Celsus, Pelops, Paulus Ægineta, and many ancient and modern writers. Tabulated cases illustrating the results of treatment with various remedies. Discussion of the relative value of the different remedies. Blood-letting. Section of Nerves. Amputation of affected limbs. Local applications. Mercury. Antimony. Tobacco. Opium. Indian Hemp, (Cannabis Indica). Woorara. Sulphuric Ether. Chloroform. Alcohol. Chloral Hydrate. Cold Bath. Warm Bath. Nutritious Diet. Relative Mortality from Traumatic Tetanus in Civil and Military Hospitals, and in Private Practice. Relative Mortality in Traumatic Tetanus, under the different modes of treatment and in the employment of various agents. Discussion of the modes of action of the various agents employed in the treatment of Traumatic Tetanus.

It is important in Traumatic Tetanus, as well as in other diseases, to determine whether the constitution be able to withstand an attack without the interference or aid of medical treatment.

The study of the disease, uninfluenced by drugs, would furnish the proper data, for the determination of the effects of remedial agents on its progress, duration and termination. Such, however, is the violence of the symptoms, and such the alarming and almost uniformly fatal nature of the manifestations of this disease, that the physician has rarely had the resolution necessary to the calm observation of the disease uninfluenced by drugs. The records of medicine, nevertheless, contain a few observations, which show that when the respiratory muscles are unaffected, patients have sometimes passed through an attack of even acute tetanus, without medical treatment. Thus, Dr. Morrison, Mr. Hennen, Mr. Morgan, Sir Astley Cooper, and others, have alluded to cases of Tetanus, in which, although the patients were left entirely to nature, without remedies, they recovered.

As Tetanus is of comparatively rare occurrence, the most distinguished physicians and surgeons rarely witnessing and recording during their entire professional life, more than a score of cases, I have deemed it of importance to give a condensed and consolidated statement, which should connect as far as possible, the outlines of the cases actually observed and treated, with the teachings of distinguished authorities, as to the best methods of treating the disease. This was especially desirable in the history of a disease, which renders the human system capable of resisting the action of the most violent poisons in fatal doses; for by such an impartial comparison of actual observavations and theoretical opinions, and empirical practice, we are enabled on the one hand to emancipate our judgment to a great extent from the influence of mere authority, and on the other hand, to establish many important facts as to the laws which govern the human system, when subjected to that peculiar excitement of the ganglionic cells of the spinal axis, which has been denominated Traumatic Tetanus.

We have therefore endeavored not only to consolidate and give the outlines of more than four hundred cases of Traumatic Tetanus, but also to embody the observations of many of the most eminent physicians and surgeons, with the hope, that the results of our labors in examining many standard works and journals, and in analyzing and condensing and consolidating a vast amount of practical observation and experimental experience, may prove of lasting value to those who may desire to arrive without a similar expenditure of time and labor at definite conclusions, as to what the Medical Profession has really achieved in the treatment of this fatal and horrible malady.

HISTORICAL NOTES ON THE TREATMENT OF TETANUS.

Hippocrates recorded five cases of Tetanus in his work on Epidemical Diseases, each of which terminated fatally. In the second chapter of these *Medical Memoirs*, in the observations on the Natural History of Tetanus, I have given these cases in full as recorded by Hippocrates. (See Cases 4, 5, 6, 7 and 8): in only one case, viz: that of Scamandrus, has Hippocrates specified the treatment. In the appendix to his Treatise on Regimen in Acute Diseases, directions are given for the treatment of Tetanus. That Hippocrates was well acquainted with the fatal nature of Tetanus, and the unsatisfactory results, if not absolute futility of treatment in this disease, is evident from his axiom, that: "*a convulsion coming on a wound is mortal.*" Hippocrates appears to have employed in the treatment of Tetanus, the warm bath, fomentations, venesection, glysters, purgatives, nutritious diet and wine.

Aretæus, the Cappadocian, correctly refers the origin of Tetanus to the nerves, and gives an accurate and finished description of the disease, but records no cases. With reference to the mortality occasioned by the disease, he remarks that Opisthotonos and Emprosthotonos, "are apt to supervene upon the wound of a membrane or of muscles, or of punctured nerves, when for the most part, the patients die, for *spasm from a wound is fatal.*"

The following are the directions of Aretœus for the cure of Tetanus:

"Now, indeed, a soft, comfortable, smooth, commodious and warm bed is required; for the nerves become unyielding, hard and distended. * * Let the house also be in a tepid condition; but if in the summer season, not to the extent of inducing sweats or faintness, for the disease has a tendency to syncope. We must also not hesitate in having recourse to the other great remedies; for it is not a time for procrastination. Whether then the tetanus has come on from refrigeration, without any manifest cause, or whether from a wound, or from abortion in a woman, we must open the vein at the elbow, taking special care, with respect to the binding of the arm, that it be rather loose; and as to the incision, that it be performed in a gentle and expeditious manner, as these things provoke spasms; and take away a moderate quantity at first. Yet, not so as to induce fainting and coldness. And the patient must not be kept in a state of total abstinence from food, for famine is frigid and arid. Wherefore, we must administer thick honeyed water, without dilution and strained ptisan with honey. For these things do not press on the tonsils so as to occasion pain; moreover, they are soft to the gullet, and are easily swallowed, are laxative of the belly, and very much calculated to support the strength. But the whole body is to be wrapped in wool, soaked in oil of musk, or of saffron, in which either rosemary, fleabane, or worm-wood has been boiled. All the articles are to be possessed of heating properties, and hot to the touch. We must rub with a liniment composed of lemnestris euphorbium, natron, and pillitory, and to these a good deal of castor is to be added. The tendons also are to be well wrapped in wool, and the parts about the ears and chin rubbed with liniment; for these parts in particular, suffer dreadfully, and are affected with tension. Warm fomentations also, are to be used for the tendons and bladder, these being applied in bags containing toasted millet, or in the bladders of cattle, half filled with warm oil, so that they may lay broad on the fomented parts. Necessity sometimes compels us to foment the head, a practice not agreeable to the senses, but good for the nerves; for by raising vapors, it fills the senses with fume, but relaxes the nervous parts. It is proper then, to use a mode of fomentation, the safest possible, and materials not of a very heavy smell; and the materials should consist of oil devoid of smell, boiled in a double vessel, and applied in bladders; or of fine salts in a bag; for millet and linseed are pleasant, indeed, to the touch, but gaseous and of an offensive smell. * * * After the cataplasms, it is a good thing to apply the cupping instrument to the occiput on both sides of the spine, but one must be sparing in the use of heat, for the pressure of the lips of the instruments is thus painful and excites contractions. It is better then to suck slowly and softly, rather than suddenly in a short time, for thus, the part in which you wish to make the incision, will be swelled up without pain. Your rule in regard to the proper amount of blood, must be the strength.

These are the remedies of Tetanus without wounds.

> But if the spasm be connected with a wound, it is dangerous, and little is to be hoped. We must try to remedy it, however, for some persons have been saved, even in such cases. In addition to the other remedies, we must also treat the wounds with the calefacient things formerly described by me, by fomentations, cataplasms, and such other medicines as excite gentle heat, and will create much pus; for in Tetanus the sores are dry. Let the application consist of the manna of frankincense, and hair of poley, and of the resins of turpentine and pine trees, and of the root of marsh-mallow, and of rue, and of the herb fleabane. These things are to be mixed up with the cataplasms, melting some of them, sprinkling the others upon them, and levigating others beforehand with oil; but the mallow having been pounded, is to be boiled beforehand in honeyed water. We are to sprinkle also some castor on the ulcer, for no little warmth is thereby communicated to the whole body, because the rigors proceeding from the sores are of a bad kind. Rub the nostrils with castor, along with the oil of saffron; but also give it frequently in the form of a draught, to the amount of three oboli. But if the stomach reject this, give immediately of the root of silphium an equal dose to the castor, or of myrrh, the half of the silphium; all these things are to be drunk with honied water. But if there be a good supply of juice of the Silphium from Cyrene, wrap it to the amount of a tare in boiled honey, and give to swallow. It is best given this way, as it slips, unperceived through the palate; for it is acrid, and occasions disagreeable eructations, being a substance which has a bad smell. But if it cannot be swallowed thus, it must be given dissolved in honeyed water; for it is the most powerful of all the medicines to be swallowed, which are naturally warming, diluent, and can relax distensions and soothe the nerves. But if they can swallow nothing, we must inject it into the anus with the oil of castor; and thus the anus is to be annointed with oil or honey. With this also we are to annoint the fundament, along with fat or honey; and also foment the bladder; and use it as an ointment, having melted it with a sufficiency of wax to bring it to the proper consistence. But if it be the time for evacuating flatulence and fæces, we are to inject two drachms of the purgative hiera along with the honeyed water and oil, since along with the expulsion of these it warms the lower belly; for hiera is both a compound and heating medicine." *The Extant Works of Aretæus, the Cappadocian.* London, 1856, pp. 400 to 404.

The Cyreniæ Silphium, employed by Aretæus, was a superior kind of Assafœtida, which at one time grew copiously in the region of Cyrene. See Paulus Ægineta, t. iii, p. 337.

Pelops recommends dry, and not moist fomentations, in the treatment of Tetanus; and affirms that the most potent cure for emprosthotonos and opisthotonos, is a fever supervening when there was none at the commencement.—The Seven Books of Paulus Ægineta, vol. i, p. 403.

Cælius Aurelianus enumerates nearly the same causes as Aretæus, and describes all the symptoms of Tetanus with the greatest precision. His treatment also is very similar to that of Aretæus, namely, emollient applications to the neck, venesection, and oily clysters. He enjoins the bath of oil, which has fallen into disuse in modern practice, most probably on account of the expense. He also permits sometimes the use of common baths, but not of cold water. He allows wine in certain cases. He condemns Hippocrates for giving both wine and emetics, and having recourse to venesection, without due discrimination. He blames him also for recommending the affusion of cold water, inasmuch as he himself had pronounced cold to be injurious to the nerves, bones, etc. Galen, however, remarks, in his commentary upon this aphorism of Hippocrates, (Sec. V, 21), that cold, in this case, is not the direct cause of the benefit derived from this remedy, but that the shock which it imparts to the system proves beneficial by rousing the vital heat and energies of the patient. Hippocrates, however, forbade the cold affusion in Traumatic Tetanus.

Paulus Ægineta affirmed that Tetanus is to be cured, like convulsions, by depletion. In reference to the "Cure of the Varieties of Tetanus," Paulus Ægineta says:

> In treating tetanic spasms, we must begin with phlebotomy, and wrapping the parts in wool which has been dipped in oil, namely, the Sicyonian and Castor, with old oil; or a broad bladder containing hot oil may be applied to the tendons. Cupping with scarificators is to be applied, for dry cupping is hurtful. The neck, both sides of the spine, the muscular parts of the breast, the hypochondria, and the region of the bladder, or kidneys, should be cupped. We must not be sparing of the detraction of blood, nor yet take away too much at a time, but at intervals. The sweats should be absorbed by wool dipped in oil, lest the patient happen to catch cold.

> If the attack of tetanus continue long, the patient must be put into a hip-bath of oil twice a day, but not allowed to remain long in it, for of all applications, the bath of oil is the most debilitating. Let him drink tepid hydromel, boiled to the one-half; and the robust may take a drachm of Opopanax; or if not so much, three oboli, or at least one obolus, if we are afraid of its proving injurious to the stomach. We must also give gum Ammoniac; or Cyrenaic juice to the size of a tare, made up with well-boiled honey, may be swallowed. Two spoonfuls of the root of laserwort may be given in three cyathi of honied water, or in its decoction; or one drachm of myrrh in honied water, in the decoction of hyssop. But the least dangerous and most effective remedy, is Castor, to the extent of two or three spoonfuls in divided doses. And it will do no harm if you give it after a meal; but the drink and the other things should be taken slowly and by degrees, for if swallowed with difficulty, the drink regurgitates at the nose, the violent agitations of which bring on convulsions. The anus should be smeared with oil of rue, along with opopanax, and the same things are to be given in a clyster.
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> The affusion of cold water being as Hippocrates says, exceedingly hazardous, and for that reason I suppose, rejected by succeeding authorities, we too are disposed to condemn. *A Liniment* of hard (Valerian), one sextarius: of wax, oz ii: of malabathrum of amomum, of storax, and of mastich, of each oz i: of castor, of adarce, of euphorbium, of pepper, of each oz i: of spikenard, of opobalsam, of each oz i.
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> *A Potion for Opisthotonos*—Of the root of panacea, of white pepper, of costus, of myrrh, of poppy juice, equal parts, give to the size of the vetch called aracus, at bed-time. It is also a remedy for orthopnoea. Let the diet be attenuant, of easy diffusion, and by all means not excitant. *The Seven Books of Ægineta, Vol. I, pages* 404-405.

Octavius Horatianus, recommends bleeding, emollient applications, purgative clysters, the tepid bath, antispasmodics, and sudorifics. The use of the last mentioned class of remedies, does not appear to have been sufficiently understood by the ancients; at all events, they were less partial to them in this case than the moderns.

The Arabians, enjoin nearly the same treatment as the Greeks. Avicenna and Meuse join the preceding authorities in recommending strongly the use of castor and assafœtida as antispasmodics. Avicenna, in common with many other ancient phyisicians, praises the bath of oil; Serapion speaks of a bath prepared with emollient herbs. Haly Abbas describes minutely the two varieties of tetanus, as occasioned by repletion and inanition. For the former he approves of purging with hot drastic purgatives, of rubbing the part affected with hot oils, and of using the warm bath, with frictions after it; he also approves of castor: for the other variety, he praises the affusions of plain water in which lettuces, barley, etc., have been boiled. He recommends the internal use of milk and other demulcents, and the bath of oil and rubbing the body with oil of violets. The treatment recommended by Alsaharavius is similar. Rhases, mentions with disapprobation, Hippocrates' proposal of the cold affusion, but recommends bleeding when there are symptoms of repletion, emollient applications to the neck, the bath of oil, the application of leeches to the part affected, purging with aloes, etc., the administration of antispasmodics, such as castor, assafœtida and the like. *Paulus Ægineta, Vol. I, page 407.*

A. Cornelius Celsus, says:

> "That the varieties of Tetanus are cured by the same method; so far physicians agree. But Asclepiades believed that blood should be let; some again affirmed that ought by all means to be avoided; for this reason, that the body then stood most in need of heat; and that this resides in the blood of the veins. This indeed is false. For it is not the nature of the blood to be peculiarly hot; but amongst the several things which compose the human body, it most grows either hot or cold. Whether or not, it be proper to make this discharge may be understood from the general directions, which were given about bleeding. But it is evidently proper to give castor, and with it pepper or laser. Then a moist and hot fomentation is needful. Therefore, most physicians, pour warm water frequently upon the neck. That relieves for the present, but renders the nerves more liable to cold, which is to be particularly avoided.
>
> It is more proper then, first to anoint the neck over with liquid cerate; next to apply ox bladders or bottles filled with hot oil, or a hot cataplasm made of meal, or pepper, bruised with a fig. But it is most suitable to foment with hot salt. When any of these has been done, it is fit to bring the patient to the fire, or if it be summer time to the sun; and to rub his neck and shoulders, and spine with old oil, which is fittest for that purpose; if that cannot be had with Syrian Oil; if that cannot be got, with the oldest fat. As friction is servic-

able to all the vertebræ, so it is particularly to those of the neck. Wherefore, day and night but at proper intervals, this remedy must be used. When it is intermitted some healing malagma must be applied. And cold is of all things to be avoided. And upon that account there ought to be a constant fire in the chamber where the patient is nursed, and especially in the morning before day-light, when the cold is most intense. Neither will it be improper to keep the head close clipped, and to moisten it with hot ointment of Iris, or the Cyprine, and to keep it covered with a cap; sometimes to dip the whole body in warm oil, or in a warm decoction of fenugreek, with the addition of a third part of oil. A clyster also often relaxes the superior parts. But if notwithstanding the pain has grown more severe, cucurbitals are to be applied to the neck, and an incision made in the skin. Eschars are to be made either by irons or mustards. When the pain is abated, and the neck has begun to move, we may know that the disease yields to the remedies. But all food that requires chewing must be avoided. Gruels must be used, also sorbile eggs, or broth made of chickens, or some other tender flesh. If this has succeeded, and the neck shall appear to be entirely well, we must begin with pulse or intrita, well moistened. But the patient may sooner venture to chew bread than taste wine; for the use of this is very dangerous, and therefore to be deferred for a longer time.

A. Cornelius Celsus, Medicine, in eight books. Translated with notes, by James Greive, M. D., Third Ed.; London, 1838, pp. 166, 168.

As far as my information extends, Dr. William Cullen was one of the first to advovote the section of the affected nerve in Tetanus, thus he says:

"When the disease is known to arise from the lesion of a nerve in any part of the body, the first, and I judge the most important step to be taken towards the cure, is by every possible means to cut off that part from all communication with the sensorium, either by cutting through the nerves in their course, or perhaps by destroying to a certain length their affected parts or extremity."

With reference to the value of Opium, Dr. Cullen expresses his belief in decided terms, thus:

"When the cure of the disease is to be attempted by medicine, experience has taught us that opium has often proved an effectual remedy; but that to render it such it must be given in much larger quantities than has been employed in any other case; and in these large quantities it may in this disease be given more safely than the body has been known to bear in any other condition."

Dr. Cullen not only advocates the use of Opium in large doses in tetanic affections, but he also advises that it be given persistently at intervals according to the severity of the symptoms, and to be continued for some time after their subsidence; and he attributes the failures with this remedy, chiefly to the timid and temporary manner in which it had been employed by practitioners. Dr. Cullen, also recommends purgatives, and the frequent exhibition of glysters when the power of deglutition fails. He suggests that Musk and Camphor might be employed with benefit in this disease, and in much larger quantities than they commonly have been in other cases. With reference to the warm bathing which had been commonly employed in the treatment of Tetanus with advantage Dr. Cullen says, that so far as he knew, it had not alone proved a cure, and in some cases either from the movement of the body or the fear of the bath, with which some patients were seized, the spasms had been aggravated, and even death occasioned. On the other hand, he was disposed by the testimony of many judicious practitioners, to regard the cold bath as of great service in this disease, arising from cold, but of less value in tetanus arising from wounds. With reference to Bleeding and Blistering, Dr. Cullen observes:

"Bleeding has been formerly employed in this disease; but of late it has been found prejudicial, excepting in a few cases, where in plethoric habits a fever has supervened. * * Blistering also has been formerly employed in this disease; but several practitioners assert that blisters are constantly hurtful, and they are now generally omitted." *First lines of the Practice of Physic.*

John Brown affirmed that the whole disease did not

Consist in spasm, and that the affected muscles are not the whole seat, but that there is extreme debility in every part, but greater in the muscles than in any other equal part. His treatment is based upon the view that Tetanus depends upon debility, thus he says: after Tetanus has taken place, as the teeth are closed by the lock jaw, there is neither access to weaker and less powerful stimuli of food and drink, which are often sufficient for the cure of diseases of less debility, nor any sense in using them; we must therefore immediately have recourse to the most powerful and the most diffusible stimuli possible, and continue their use without regard to quantity, not even to that of Opium itself, till the whole tumult of the disease is allayed.—*Elements of Medicine.*

Neither Cullen nor Brown report any cases of Tetanus, in support of their views.

Benjamin Rush, of Philadelphia, affirms that Tetanus may sometimes be arrested after the appearance of the first symptoms, by an emetic, a large dose of laudanum, the warm bath, and Peruvian Bark. He also states, that in "*many hundred instances* the most salutary effects had arisen during the first appearance of the symptoms by opening and dilating the wound, and by the application of such irritant substances as Spanish flies, Corrosive Sublimate and oil of Turpentine. Dr. Rush recommended Opium in large and frequent doses, and wine in *quarts* and *gallons* daily. Dr. Rush says that the cold bath had been revived by Dr. Wright, of Jamaica, and had in many instances performed cures of this disease; he admits however, that this remedy had not proved beneficial in the hands of some, and quotes the testimony of Dr. Girdlestone to the effect that in the East Indies, the cold bath had uniformly destroyed life in every case in which it was used. Dr. Rush has seen the happiest effects from the administration of six or eight drops of the oil of Amber, every two hours in this disease.

According to John Hunter, in the treatment of Tetanus:

> "All the anti-spasmodics have been given, but without apparent success; Opium has kept its ground longest, but with little reason, as it only quiets; but from some patients having got well under its use, its name has been raised; I have tried it both in large and small doses, though always unsuccessfully. I think medicines have no power without they produce some visible effect: Opium never removes the cause, though it will prevent the effects: it cures spasms and removes pain, but it does not remove the cause. It often does good, by not allowing the symptoms to do harm to the constitution. The first appearance of a cure is a recovery of strength, as weakness is a pre-disposing cause; and the first indication should be to strengthen the system. I should recommend everything to produce external cold, as cold applications, consisting of snow with salt, to the part, and that the patient should be put into an ice house, or sent to a cold climate, as soon as possible. I know of no internal medicine. * * Electricity has a temporary effect in relaxing the muscles, and in partial affections has cured by rendering the contractions less violent." Works of John Hunter, edited by James F. Palmer, London, 1837, vol. i, p. 588.

John Hunter records four cases of Traumatic Tetanus; 1st, treated with Opium, and Blood-letting; 2d, with Opium; 3d, Acetate of Lead; 4th, Assafœtida and Opium; each case terminated fatally.

Baron Larrey, who, without doubt, had a greater experience in the observatio treatment of Traumatic Tetanus in different countries and climates, than any ot military medical officer and surgeon, in direct opposition to the skeptical views of J Hunter, and others, as to the value of remedies in this disease, lays great stress u the value of certain measures. Thus Baron Larrey says, with reference to the l treatment:

> "Experience proves that when tetanus is abandoned to the resources of nature, the pa soon dies. The physician should hasten to counteract the symptoms presented by the dis The first object is to remove the causes of irritation, and to re-establish the suppr excretions. This is to be effected by suitable incisions in the wound made before inflam tion takes place; for should this be much advanced, incisions are useless and even danger when necessary, we should include as much as possible of the wounded nervous cords membranes, but incisions at the articulations are dangerous, and appear generally to incr the symptoms of tetanus; I have seen examples of this. Caustic applications to the wo may be made with advantage, on the first appearance of the symptoms, provided the sa rule be observed as in the case of incisions. To these operations should succeed bleedin necessary, and the use of anodyne and emollient local applications, though these effects a generally feeble.
>
> Internal remedies, whatever may be their properties, are almost always useless, beca

the patient in a short time after the appearance of tetanus, falls into a state of strangulation; but should this not take place in the early stages of the disease, such remedies may be employed as physicians most confide in; for instance, Opium, Camphor, Musk, Castor, and other antispasmodics, given in large and gradual doses." Memoirs of Military Surgery, vol. i, pp. 138–9.

According to Baron Larrey, mercurial frictions aggravated the disease in Egypt; Cataplasms of tobacco leaves and alkalies, applied to the wounds, were productive of no good effects; and blisters applied to the throat did not arrest its progress. Moxa, and the actual Cautery, although recommended by the Father of Medicine, were followed by the same results.

Baron Larrey not only proposed, but practiced amputation for the relief of Traumatic Tetanus, believing as he did that, *it is better to amputate the wounded limb as soon as the symptoms of tetanus appear, than to rely on the uncertain resources of nature and art to effect a cure.* From his first series of cases, recorded in his *Memoir on Truamatic Tetanus*, contained in the first volume of his *Memoirs on Military Surgery*, Baron Larrey concludes:

1st. "That of all the remedies proposed by skilful practitioners, experience has proved to me, that extract of opium, combined with camphor and purified nitrate of potassa, and dissolved in a small quantity of emulsion made from the cold seeds of sweet almond, and given in strong doses acts most favorably, because the sick have a repugnance to all other liquids, while they take this liquid with pleasure; and that its effects may be seconded with venesection if necessary, and by vesicatories under such circumstances as I have before mentioned.

2nd. "That amputation performed at a proper time, is the most certain means of arresting tetanus, when it is produced by a wound in the extremities." p. 153.

In the second volume of his Memoirs on Military Surgery, Baron Larrey records additional observations on Traumatic Tetanus, thus he says,

"I have often removed the symptoms of incipient tetanus, by adopting such means as are suited to remove its causes, viz: by cutting the ligature of an artery in which a nerve is included, and to which the patient refers all his pain, and where the nervous irritation takes its rise. This division of the ligature arrested the disease in its forming stage, and expedited the cure of the wounds. There is no danger of hæmorrhage if the vital powers be not debilitated, and there be no predisposition to adynamia. A few hours of direct compression, which brings the walls of the arteries into contact, are sufficient to induce adhesive inflammation, as explained in the Memoir on Hæmorrhage. In order to perform the delicate operation of dividing the ligature of an artery, a grooved probe is to be introduced between it and the artery, and the point of a very straight pair of scissors is to be passed down this groove to cut the ligature. I have succeeded in this operation five times, * * *

Epispastics of Cantharides applied to the wounds in which suppuration is suspended, and the divided nerve irritated by contact of cold, moist air, will also prevent tetanus. When these applications are made on the appearance of the first symptoms, the natural sensibility of the diseased nerve, and the secretion of pus will be re-established. The cutaneous transpiration is to be promoted at the same time by embrocations of very warm camphorated oil of chamomile, with the addition of tincture of opium, by covering the patient with flannel, and by the exhibition of vermifuge medicines, if there be a suspicion of worms in the intestines. I have used these remedies with success when cold has been the predisposing cause. When I suspect the compression of a nerve, by the enlargement of the neighboring vessels, or by the adhesion of parts of the cicatrix, I do not hesitate to apply the actual cautery until I reach the points of the divided nerve, and sometimes I carry the cautery even to a greater depth. This application justly recommended by the physicians of antiquity, has produced most surprising effects. By destroying adhesions and preventing the twitchings of the nerves, it removes spasm and irritation." Vol. II, pp. 300–301.

In his Surgical Memoirs, on the Campaign of Russia, Germany and France, Baron Larrey, states that after the battle of Dresden, (August 27th, 1813):

"Wounds of the joints, and those complicated with fractures were thwarted shortly afterwards by that sad affection tetanus, which we have so often observed, and almost always in moist seasons or where the temperature passes suddenly from one extreme to another. Among the means employed by us in its treatment, was the actual cautery applied to the wounds. This agent and the amputation of the injured limb, saved the lives of some patients, the history of which cases I was not able to collect in consequence of my being obliged to follow the movements of the army," p. 268.

Baron Larrey appears to have been the first surgeon to practice amputation for the relief of Traumatic Tetanus: but, Mr. G. Hicks, surgeon of Baldock, is regarded as the first to divide the nerves for the relief of Tetanus. He proposed to treat Hydrophobia, by dividing the nerves supposed to be acted on by the virus of the mad dog; and he instanced the following case of tetanus, in which this mode of treatment was tried in 1797.

Case 60: Traumatic Tetanus cured by section of the nerve, by Mr. G. Hicks, 1797.

A cooper was attacked with trismus which appeared to come on gradually in the course of a few hours, after a contusion of the palm of the hand. Mr. Hicks saw him about three weeks after the injury, at which time the jaws had been completely locked for four days. Observing at the seat of injury a tumor in a state of suppuration, he made an incision through it, cutting down between the metacarpal bones with a view of relieving the nervous system, by a division of the nerves affected. Opium was afterwards given in large doses, and the next day the patient could open his mouth and swallow fluids with ease, the rigidity of the muscles of the throat and face, being in a great measure relieved. London Med. and Phys. Jour. Vol. XVII, p. 277.

Mr. John Hennen declares in his *Military Surgery*, (London, 1829, 3d Ed. p. 249), that he had never been fortunate enough to cure a case of Symptomatic Tetanus; in some instances of the *Chronic* species, however, he had effected, or witnessed relief: in one instance in which a cure was effected by mercurial inunction, the patient expired several weeks after of *Mercurial Marasmus*: in another amputation of the wounded limb relieved all the symptoms, but the patient died of a fever, which hung upon him during the whole period of the complaint and carried him off in the sixth week. In Mr. Hennen's last case, venesection and the use of tobacco injection, (which brought away enormous quantities of hardened fæces), after five days perseverance relieved all the symptoms, and the employment of Ether and the Tincture of Opium in frequent small doses, removed the occasional spasm that occurred, the bowels being carefully watched. The disease lasted for seven weeks. But in another case precisely similar, treated in the same ward, at the same time, on the same plan, and by the same medical assistant, the usual fatal termination occurred on the 15th day.

Whilst Sir James Macgrigor, was unable to say precisely the number of cases of tetanus treated under the head of *wounds*, he states that there were some hundred cases in the British armies, during the campaigns in the Peninsula of Spain and Portugal, which offered room for extensive trials of remedies. He gives brief histories of only six cases of tetanus which recovered, and after general observations upon the different remedies employed, concludes thus:

> "I am however, obliged to confess that little or no dependence is to be placed in any of the remedies, and I have to regret that the method of cure is yet to be discovered.
>
> "Judging from the very few successful cases, we may be disposed to trust principally to blood-letting, purging, opium and digitalis. As the disease appears to terminate in free sweating, in some of the few successful cases, Dover's powders may be useful, and the vegetable alkali and tobacco fume are deserving of farther trial."

With reference to Amputation, Sir James Macgrigor says:

> "Amputation as recommended by the Baron Larrey, totally failed in the fully formed disease: it was tried in many cases at Toulouse. Indeed I believe this gentleman's opinion is altered since he published the result of his experience in Egypt. I had some conversation with him on the subject, but I have been recently informed by Mr. Guthrie, that the Baron distinctly acknowledged to him, that the loss of the French army after the battle near Dresden. was principally from Tetanus, when of course, this practice must have been fairly tried." Medico Chirurgical Transactions, 1815, Vol. VI, p. 449–459.

Dr. J. H. Dickson, M. D., Physician to his Majesty's Fleet, after presenting some observations on several very severe cases of Tetanus, which occurred in the wounded of the British Forces, in the expedition against New Orleans, affirms that he was justified in inferring:

> "That to the improvements in the medical and surgical treatment of wounds; in cleanliness and ventilation, avoiding at the same time exposure to currents of cold air, or sudden changes of temperature; in fine, to superior comforts, diet and accommodation; but particularly, to the greater attention paid to the state of the bowels, may be attributed the greater infrequence of tetanus of late in the West Indies, when compared with former wars." Medico Chirurgical Trans. VIII, p. 465.

Sir Gilbert Blane, says, that only three wounded men recovered in the whole fleet, after the action of April, 1782. The wounded amounted to eight hundred and ten, and sixteen of this number were destroyed by tetanus. Sir Gilbert Blane, expressed it as the result of his experience, that the cure of tetanus, depends chiefly on the judicious employment of Opium and the warm bath. He recommends that the opium be given in moderate doses, often repeated, and he gives 93°, F., as the best temperature for the bath.

Dr. James Currie, in his Medical Reports, says that amongst the various remedies which had been proposed in the treatment of Tetanus during the preceding thirty years, only Opium, Mercury, the cold bath, and wine, seemed to be entitled to any reputation. In the use of the cold bath, Dr. Currie, appears to have been more successful in Idiopathic than in Traumatic Tetanus. Mr. Benjamin Travers, on the other hand, in his *Further* Inquiry concerning Constitutional Irritation, says that from the plunge of the cold bath, he has seen the tetanic patient brought up a corpse, and has known an hydrophobic patient expire in the spasm induced by the act of incising the wound.

Mr. Travers objects to opium, because it raises and swells the pulse, and for a time at least augments the muscular energy, and in truth does not cease to do so until it induces a state resembling drunkenness, or congestive apoplexy. Antimony induces nausea and vomiting, purging and perspiration, and thus relaxes muscular power; but its effect is too indirect and uncertain, both as to its time and extent of operation upon the nervous system, and too little controllable, within the limits desired, to recommend itself to our selection in these cases. On the other hand, Mr. Travers advocates the free and continued use of the infusion of Tobacco, in the following manner:

> "The infusion of tobacco injected per anum, beginning with half a drachm of the dried leaf, to a pint, and increasing the strength to double, if indicated, may be employed with signal effect in calming the spasm of Tetanus. It may be used twice or thrice daily with perfect safety in the onset of the disease. It produces nausea, perspiration, and sleep, often of hours continuance; but above all it diminishes its force and frequency if it does not arrest the morbid action, and gradually restores the pliancy of the fixed and board-like muscles. To counteract its depressing effects, and indeed to support the patient, under the disease, independent of all medicinal remedies, I give strong animal broths or jellies, and alcohol in the form of brandy or wine, every hour or two; and this I hold to be a not less important indication of treatment. Patients have been lost in Tetanus from want of proper nourishment and cordials, oftener than from want of proper medicine, pp. 301, 306."

Mr. Thomas Blizard Curling, after the examination of the records of 128 cases of Traumatic Tetanus, arrived at the following conclusions as to the treatment of this disease which I have condensed and consolidated from his *Treatise on Tetanus.*

Local Treatment.—Mr. Curling dismisses at once from the inquiry, the propriety of using the actual cautery, and other stimulating local means, to restore the suppurative process or healthy action, since such barbarous treatment is not sanctioned by experience, and its utility is unsupported by any rational views of the pathology of the disease.

To prevent the propagation from the wound of the irritation supposed to be the cause of the disease, two plans have been adopted. 1st, Amputation or excision of the wounded part; 2d, Division of the nerves proceeding to the seat of injury. In amputation many nerves are necessarily divided, and cases have been recorded in which Tetanus was the sequel of its performance.

Mr. Curling considers amputation as altogether so severe and serious a mode of treating the disease, that we can scarcely ever be warranted in resorting to it, when the original wound is slight, especially as if employed under the most favorable circumstances a successful issue can never be depended on. In chronic tetanus as patients usually recover, it is certainly inadmissible, even when the wound is severe and in an unfavorable state, unless its condition be sufficiently bad to demand the operation independently of the spasms. Amputation can only be regarded as a justifiable proceeding after a severe injury of the extremities, as a compound fracture or an extensive laceration, immediately that there is the slightest indication of spasms, for if delayed until the disease is more advanced instead of proving beneficial, it will tend rather to aggravate the symptoms and to render the constitution less able to sustain the debilitating effects of the spasms. With reference to the division of the nerves the same principle applies, for unless the operation be performed very early, there can be little hope of a favorable result. When it is possible to divide all the nerves proceeding to a slight wound, this plan is infinitely preferable to amputation, since all the advantages of the latter may be obtained by an operation far less painful, severe and serious in its consequences. Paralysis may be the immediate, but is not likely to be a permanent result. This operation therefore may be regarded as well worthy of a further trial.

Purgatives—As sources of irritation in the intestinal canal, and obstinate constipation so frequently exist, too much importance cannot be attached to the employment of purgatives. A brisk Cathartic, by causing the expulsion of worms or unhealthy fæces, has produced almost immediate relief in the idiopathic form. One of the most important consequences of the free operation of purgatives, arises from their favoring the action of those remedies, which more immediately influence spasmodic contractions; indeed, until the bowels have been fully relieved, it is almost useless to resort to other medicines. Those purgatives should be selected, which being nearly soluble, act quickly and powerfully on the intestinal canal, as oil of turpentine, and croton oil, especially the latter, since in addition to its active and rapid operation in cases of difficult deglutition, a few drops upon the tongue, will generally be sufficient to obtain the desired effect. If any impediment to the evacuation of fæces is occasioned by spasm of the spincter, or levator ani muscles, and if they are found firmly contracted, an enema of an infusion of the tobacco leaf, containing laudanum, will most probably be found successful. The action of the bowels must be steadily maintained throughout the disease.

Mercury.—Although Mercury has gained some repute, as a remedy in tetanus, the evidence of latter practitioners, in regard to its influence in controlling the progress of the symptoms is far from favorable. The constitutional effects of Mercury will not arrest the disease, for patients have been known to expire with a stream of saliva flowing from their mouths. Mr. Curling and others, have recorded cases, in which extreme suffering was occasioned by the increased secretion of saliva. Of 53 cases in the table of Mr. Curling, where Mercury was employed, 31 proved fatal. Of the 22 cases which recovered, in 20 Opium was combined with this remedy, and of the two treated without it, in one tobacco injections were employed. In 11 of the cases in which, neither Opium nor tobacco was resorted to, the Mercury being given alone, or employed in conjunction with some trival remedy, as the warm bath or blisters, *all were fatal except one.* Twelve cases of tetanus, consequent upon severe injuries, are related by Mr. Howship, in all of which Mercury was fully exhibited. Two only recovered, and in both of them it was given in conjunction with Opium. As the symptoms may make considerable progress before the system is brought under its influence—as it can possess no specific power over the disease—and as debility is increased, the sufferings of the patient are seriously aggravated by the production of ptyalism; in the pure traumatic form of the disease, the free use of Mercury must be regarded as not only useless, but exceedingly injurious.

Blood-Letting.—By cautiously analyzing the pathological characters of Tetanus, it has been attempted to establish a proposition of the highest import, in regard to the treatment of this disease, viz: *that it is not essentially an inflammatory disease,* most cases of the traumatic form being unaccompanied with febrile disturbance, or with any symptoms indicating the necessity for active depletion. Autophlogistic treatment therefore, is generally unnecessary for its removal; but in these cases, where inflammation is the cause of tetanic irritation, which though rare in the traumatic form, is a frequent occurrence in the idiopathic, abstraction of blood may be highly beneficial. With a view of removing congestion of the vessels of the medulla-spinalis, Mr. Swann, and other practitioners, recommended the abstraction of blood in the course of the spine. Numerous experiments and observations have shown that this state, not of congestion, but of vascular excitement terminating in serous effusion, which it is contended, is the effect and not the cause of tetanic irritation, is also a very frequent result of excessive loss of blood; hence, unless other circumstances indicate the propriety of local depletion, such a practice should be adoped with the utmost caution, since in some cases, it might aggravate, and in none is it likely to remove the disease. In traumatic tetanus, occurring to a highly plethoric individual, with a hard and full pulse, but without any symptoms of febrile disturbance. bleeding may perhaps be resorted to, with advantage in the first instance. But at a more advanced stage of the disease, and in a debilitated state of the system, even moderate bleeding is altogether inadmissible. Although violent muscular action is maintained in an extraordinary manner for a considerable time, yet great exhaustion is ultimately produced; it is therefore always an important object in the treatment of tetanus, to sustain the powers, so that the constitution may be enabled to withstand, both the debilitating effect of the disease, and the depressing influence of those remedies best adapted to subdue the spasms.

Counter Irritation.—Either over the affected muscles, or in the course of the spine, is of no service.

Various remedies, as Camphor, Musk, Digitalis, Stramonium, Conium, Hyosciamus, Belladonna and Lead, have proved utterly inadequate to allay the excitement in the nervous system, giving rise to undue muscular action.

Opium.—Of the numerous remedies that have been called in aid, in the treatment of Tetanus, none have been more frequently, or more extensively employed than Opium. And there is no question, that in many instances it has succeeded in allaying the spasms; but as it is resorted to, in, by far the greater number of tetanic cases which occur, too much importance must not be attached to its occasional success. Opium in various forms, and in conjunction with other remedies was employed in 84 of the 128 cases of Tetanus in Mr. Curling's table, being more than two-thirds of the whole number. Of these forty-five recovered, of which ten were females.

In tetanus, as well as in hydrophobia and delirium tremens, there appears to be a conventional license for the unlimited exhibition of Opium; and yet the enormous doses in many cases exert not the slightest effects upon the system. Although in Tetanus, the cerebral functions are undisturbed, yet Opium not only fails in allaying spasms, but is generally, equally powerless as a narcotic; whereas, in those cases in which it controls the muscular contractions, its narcotic effects are invariably produced at the same time. Morphia does not possess the constipating qualities of Opium; and in cases attended with difficulty of deglutition, its effects may be obtained by application to the skin denuded of its cuticle.

Tobacco.—The earlier writers had great confidence in the efficacy of tobacco, especially of the oleum tobacci, when applied externally to the neck and back. Tobacco has two active principles, an essential oil and nicotine. According to the experiments of Sir Benjamin Brodie, the former produces its effects on the brain, without directly acting on the circulation. The latter influences the heart through the medium of the nerves, rendering it insensible to the stimulus of the blood; and it has been suggested, that the spinal marrow is that part of the nervous syetem primarily affected. The symptoms occasioned by the influence of Tobacco on the system, are extreme and alarming prostration, great reduction in the pulse, nausea, vomiting, tremor, syncope, cold sweats, and paralysis of the muscles of voluntary motion. This state of prostration bears some analogy to the state of extreme depression to which the spasms give place just previous to death, after the more violent paroxysms of Tetanus. But there is this essential and important distinction; in the one case, prostration is occasioned by a sudden and powerful impression on the nervous system, which, if not carried too far, is only temporary, the vital powers not being permanently impaired. In the other, however, the powers of the system are so complétely exhausted, reaction cannot take place unless it be artificially excited, and very often, not even then. There is perhaps no medicine, which tends so powerfully to relax muscular action as tobacco. Of nineteen cases in Mr. Curling's table, in which tobacco was employed, nine recovered. Of the ten fatal cases, in several cases the remedy was either employed when the patient was dying, or it was not fairly tried. Mr. Curling conceives that more has been adduced in proof of the efficacy of tobacco, than can be adduced in favor of any other remedy yet resorted to. He even goes so far, as to affirm, that he had not succeeded in finding a single case, in which, being fully tried before the powers of the constitution had given way, it has been known to fail. Many more cases have been cured by the use of Opium, and for the obvious reason, that a far larger number have been treated by it. Tobacco is a more certain and potent remedy than Opinm, the latter being a remedy that can never be relied on, having failed far oftener than it has cured. While admitting that in its worst forms, Tetanus is a disease of too destructive a nature to be arrested by any treatment whatever, at the same time he held it to be the best remedy that the profession possessed at the time that he wrote his work, and a remedy which will generally be found capable of diminishing the severity of the acute disease, and often of subduing it altogether. The doses should be regulated by the age, habits and constitution of the patients, who, during its use, must be supported by a nourishing diet, tonics, wine and other stimulants. The carbonate of ammonia in particular, is well adapted to counteract the extreme prostration sometimes induced. At the commencement, a scruple of the tobacco leaf infused in eight ounces of water, will be enough for an injection, which must afterwards be increased in strength, in proportion to its effects. A stronger infusion will be necessary for those who are accustomed to the use of the plant as a luxury. Unless in Chronic Tetanus, baths impregnated with it, are not only inefficient, but objectionable.

Antimony—Antimony being a remedy which diminishes the heart's action, and depresses the vital powers, has sometimes been employed for the relief of Tetanus. Of ten cases in the table of Mr. Curling, in which antimony was resorted to, six were fatal but in these the disease was very acute. In the opinion of Mr. Curling, this remedy is best adapted to the more chronic forms of the disease, for although it has a decided influence in lessening muscular energy, its depressing effects are too uncertain, and are generally insufficient in power to arrest the course of the acute disease.

Cold Affusion—It must be acknowledged that the evidence in favor of cold affusion chiefly refers to cases of the idiopathic form of tetanus. With the exception of tobacco Mr. Curling knew of no remedy so well adapted to produce an impression on the nervous system, of power adeqate to control the severe spasms of the disease, as cold affusion. And he believed in the most aggravated cases, by perseverving in the application of it until syncope or extreme depression of the vital powers is produced, the spasms may be completely removed. Unless however, a powerful impression is made and kept up for some time, and the remedy repeated as soon as the spasms recur, it will prove ineffectual. The utmost care is necessary not to carry it so far as to take away all power of reaction, and it may be desirable to administer brandy, or a diffusable stimulant during the application. The remedy possesses this advantage, that other means fitted to cause the same effects, may be combined with it. Of twelve cases in the table of Mr. Curling, in which cold affusion and other means were adopted, seven terminated favorably. *Treatise on Tetanus: Phil., 1837, pp. 66–105.*

The three objects of treatment upon which Mr. Lawrence placed reliance were, first, venesection in the early stage, until the symptoms of general fulness of the vascular system are removed; second, the free exhibition of aperients, so as to remove costiveness; and third, the employment of opium for lessoning or controlling the very painful spasms. *Lancet, January 20th, 1830, p. 389.*

Mr. O'Brien, has used the extract of hemp, (Hemp Resin), in seven cases of Tetanus, of which four were admitted in a hopeless state. He employed the remedy in ten grain doses dissolved in spirit. The effect which he describes is almost immediate relaxation of the muscles, and interruption of the convulsive tendency. Of Mr. O'Brien's seven cases, four recovered. In the Police Hospital of Calcutta, the late Dr. Baine, used the remedy in three cases of Traumatic Tetanus; of these, one died and two recovered. The preceding facts, says Dr. O'Shaughnessy, seem unequivocally to show, that when given boldly, and in large doses, the resin of hemp is capable of arresting effectually the progress of this formidable disease, and in a large proportion of cases of effecting a perfect cure. *Lancet, 1840, pp. 539–540.*

Dr. Marshall Hall, discarded the terms idiopathic and traumatic, and proposed in their stead to divide tetanus into centric and eccentric. According to Dr. Hall, centric tetanus, is that produced by disease within the spinal canal itself; eccentric tetanus arises principally from a wounded, lacerated, or punctured nerve, and possibly from other sources, as deranged stomach, deranged bowels, etc. Eccentric tetanus may therefore be both traumatic or idiopathic.

The labors of Dr. Marshall Hall were important, in that they established correct views of the essential nature and relations of tetanus. Thus he held that the influence of the lesion of the nerve, is not only carried by excitor nerves to the spinal axis, and reflected upon motor nerves, but it frequently pursues a retrogade course along the spinal marrow; a wound of the foot, not less than a wound of the hand leads to trismus. A similar event occurs in experiments upon the decapitated turtle. If one of the lateral nerves be laid bare, and pinched continuously, the muscles of the upper extremity as well as of the lower are forcibly contracted. This according to Dr. Marshall Hall, is the very type of Tetanus. The treatment proposed by Dr. Marshall Hall however, contained nothing new. Thus he says:

> "The principles of treatment would appear to be; 1, to divide the injured nerve; 2, to subdue the spasmodic affections by such remedies as the Hydrocyanic Acid; 3, to prevent organic changes in the nervous system by depletion, general and local; 4, to remove all sources of irritation as scybalae in the bowels, etc., and 5, to avoid all sources of augmented spasm, such as shocks, noises, etc." Lectures on the Theory and Practice of Medicine. *Lancet*, February 14th, 1838, p. 69.

M. Matteucci, appears to have been the first to recommend and apply the continuous electric current in the treatment of Tetanus.

In a letter addressed to the Institute of France, M. Matteucci observes:

> "That every natural philosopher who has made any experiments relative to the passage of electric currents through the limbs of a frog, must have remarked that the animal is seized with a kind of tetanic convulsion, during which the limbs become rigid and inflexible. Volta however remarked that by passing the current of electricity continuously, and in the same direction, the contractions soon cease altogether."

Setting out upon this principle, M. Matteucci endeavored to apply it to the cure of tetanus, and to discover how far the direction of the current, and the mode of introducing it might influence the muscular contractions. His first experiments were made upon frogs, and from these, he concluded that the most advantageous method was that of introducing the current in such a way as to determine the least possible contraction; he also found the tetanic state most readily overcome by the inverse current. Having completed his experiments on animals, M. Matteucci looked forward with anxiety to the time when he could apply the results to the human subject. An opportunity was at length offered by Dr. Farina, of Ravenno, who was called to attend a patient affected with tetanus, brought on by a gun-shot wound. The case was an unfavorable one, as the muscles and tendons of the leg contained a great number of grains of shot, the exciting cause of the tetanus being thus constantly in operation; the remedy besides, was not applied until ten days after the reception of the wound, and at the very height of the disease. The machine employed contained from 25 to 35 plates; the electric current was passed along the spinal marrow, from below upwards, for half an hour, without interruption; it was repeated six times during ten days that the man lived. The moment that the electric current was established the man became calm, to the surprise of the numerous physicians surrounding him: his muscles became relaxed; the skin was covered with moisture, and the circulation became tranquil. Such indeed was the effect produced that the patient constantly cried out for the electric pile. Unfortunately M. Matteucci was confined to bed by a broken leg, and unable to direct the necessary observations; the persons to whom they were entrusted could not keep up the electric current, even though the pile was renewed. Although the case finally terminated fatally, the good effects produced were so manifest, that M. Matteucci looked forward with confidence to favorable results, in future applications of the *Continued Electric Current* in the treatment of Tetanus. *Lancet*, 1838, p. 350.

In his Report of seventy-two cases of Tetanus, occurring in Guy's Hospital, since the year 1825, Mr. Alfred Poland has given some interesting statistics, to which we have before alluded. I will now record such facts as bear especially upon the prognosis and treatment of the disease.

In thirty-two full years, there occurred seventy-two cases of Tetanus, in Guy's Hospital, in 113,020, total admissions. There were sixty-two deaths in these seventy-two cases of tetanus. Of the cases of tetanus, all had a co-existing or previous lesion of surface. The severity of the symptoms bore no relation to the degree of local injury. In 86.56 per cent, tetanus occurred after wounds of the extremities. The symptoms occurred before the tenth day, in thirty-one cases in sixty-three; between the 10th and 22d, in twenty-six cases in sixty-three; above twenty-two days in six cases. The interval preceding the attack did not determine the form of the disease, that is, that the disease is sometimes of the severest and most rapid description when an interval of ten days has elapsed. On the other hand, when the disease follows close upon the injury, it is for the most part uncontrollably rapid and fatal. As respects the mode of dying, nineteen died during a paroxysm, with spasms and convulsions; thirteen from asphyxia, and suffocation, and ten from exhaustion. In one case the heart's action continued for some time after the patient had ceased to breathe. Of the sixty-two cases which terminated fatally, thirty-two or 51.62 per cent, died before the end of the fifth day. The statement generally quoted in medical works, *that if tetanus continue over a period of twenty-two days, recovery is certain*, was found to be incorrect; two of the cases at Guy's were fatal, over this period, one on the twenty-eighth, the other on the thirty-second day. Ten died on the seventh, and eleven on the fourth day, while on no other day did more than five die, and then it was on the third and sixth, or the days immediately preceding those of the highest mortality. With reference to the treatment adopted: no benefit was experienced from local measures, which consisted in laying the wound freely open, in amputation, in division of the nerves near the seat of the wound, in baths, and in applications of any description to the wounds, the spine, the neck, spine and abdomen, and to the region of the diaphragm. The abstraction of a tooth in order to administer food, in one case, was followed by immediate death. In the constitutional treatment of two cases, those medicines which support the system, and which would render the patient more able to fight against exhausting disease, seem to have been most efficaceous. At all events, in the ten cases of recovery, quinine was given in seven, and in the others, wine, mush and tonics. Of the twenty-five cases in which quinine was given, seven recovered; the doses were about one grain per hour, given every third or fourth hour. Cannabis Indica and chloroform, remedies which are in vogue in the treatment of tetanus in this country were of no service; in most of the cases in which chloroform was given, the disease was aggravated.

Dr. Jackson, (Indian Annals, October, 1853), has drawn up a careful paper on the treatment of tetanus in the Native Hospital, at Calcutta, with a view of showing that great relief is afforded in that disease by the repeated inhalation of chloroform, added to the internal administration of hemp and aloes; and in the latter stages, of quinia, and generous diet; and that many more cases of recovery have resulted from this plan than from any other. It is worthy of remark however, that the same beneficial influence does not appear to be exerted in the cases of idiopathic tetanus, as in the traumatic form—this disease generally proving much more intractable. Only three cases of idiopathic tetanus came under treatment at the Native Hospital during 1852, and they all proved fatal, whilst out of twelve cases of traumatic tetanus, there were seven recoveries and only five deaths. According to the old plan of treatment adopted in the earlier part of the year, there were *five* out of *seven* admissions.

On the other hand, Professor Laurie, (Glasgow Medical Journal), has tried chloroform or ether inhalations in nine cases, all of which (except one of trismus) died. He says:

> "If no remedy yet tried has done good, and many more have done harm, how are we to treat tetanus? I reply negatively; put the patient in a dark room, keep him absolutely quiet, don't torture him with remedies which have been proved to be useless, give him as much nourishment as he can swallow, and trust the result to the power of his constitution. And if *the spasms are severe alleviate them by chloroform.*"

Dr. Bretton, (Philadelphia Medical Examiner), relates a case of traumatic tetanus, which he considers to have been cured by chloroform inhalations. Mr. Harding, (Lancet), speaks very warmly in favor of chloroform inhalations in tetanoid conditions. Dr. Symes, (Dublin Hospital Gazette), details the particulars of a case of traumatic tetanus, in which chloroform inhalations were used with great success. Rankin's Abstract, 1854, p. 59.

In a series of forty-three cases of tetanus occurring in various British Hospitals, and reported in several numbers of the Medical Times and Gazette, 1854, chloroform was tried in twelve instances, of which, eight died and four recovered. A writer in the Medical Times and Gazette, June 17th, 1854, concludes after a review of these forty-three cases,

> 1st. "That in a majority of cases, inhalation of chloroform may be practiced with safety, as regards immediate consequences.
>
> 2d. "That it is always effectual in allaying spasm for the time.
>
> 3d. "That it exerts however, no preventive influence whatever, the spasms usually returning with an increase of severity, shortly after its suspension,
>
> 4th. "That its continuous administration over long periods of time, is not to be recommended, since the patient sinks at least as fast, if not faster, than when the disease is allowed to display itself.
>
> 5th. "That it is of great benefit in certain protracted cases, simply as an alleviant of pain. In some of these it will procure rest for periods, often of an hour or more after the suspension of the inhalation, and acts altogether much more favorably than in earlier stages.
>
> 6th. "That in certain protracted cases, it is of the greatest use, in enabling a patient while in a state of half insensibility to take food, who would otherwise be unable to swallow.
>
> 7th. "That excepting for the two last named purposes, its use does not seem to be attended by any commensurate benefit, while it may much interfere with the action of other remedies, and may possibly be actively injurious itself."

The late Dr. Robert Bentley Todd* held, that the pathology and clinical history of tetanus, point out three objects, which the practitioner ought constantly to keep in view in its treatment; viz: 1st. To support the strength of the patient, so as to oppose the exhausting effect of the convulsive paroxysms. 2d. To remove all possible sources of irritation, or of depreciation of the blood, by vitiated secretions, bad diet, impure air. 3d. To diminish and reduce the exalted polarity of the nervous centres to their normal condition, and if possible, to effect this by means which will not exhaust or reduce the powers of the patient.

To fulfil the first indication, in addition to the various articles of food best adapted to the assimilating powers of the patient, administered in small quantities, and at short intervals, and also to wine or other alcoholic stimulants, the practitioner ought not to withhold the liberal use of quinine, ammonia, iron, or other drugs, which exert a tonic power over the system in general.

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*Medical Gazette, 1849, p. 766. Rankin's Abstract, 1849, p. 41. Clinical Lectures, on Affections of the Nervous System, 1855, p. 276.

In fulfilling the second indication, whilst the bowels are kept open, drastic purgatives should be avoided; too profuse sweating or diuresis should be guarded against.

> "To obtain the third object, namely: to reduce the polarity of the spinal cord, is at once the most important and the most difficult. The various sedative remedies, opium, hydrocyanic acid, belladonna, conium, tobacco, have been fairly tried and failed. Opium is not a sedative to the spinal cord; its use in tetanus may be laid aside, except in small doses as a sudorific. In cold-blooded animals, it exalts the power of the spinal cord, and it is not impossible that in warm-blooded animals, it may have a similar tendency; it is, therefore, a remedy of little value in tetanus save as a sudorific, and in large doses it may be of an injurious tendency.
>
> "Neither is hydrocyanic acid a sedative to the spinal cord; on the contrary, it tends to produce epilepsy, and to excite the polar state of the cord, by induction from the brain. Belladonna has a decidedly sedative influence, but it disturbs the action of the brain so much, that it is not a safe or manageable remedy. The same may be said of conium. Tobacco undoubtedly reduces the polar state of the cord, but it produces at the same time a state of fearful depression. It is likewise an unsafe and not a manageable remedy. I have seen more than one patient die, cured of tetanus, under this remedy.
>
> "There are two agents which certainly exert a considerable power over the polarity of the spinal cord, which have not yet been tried sufficiently fairly, and which I think fully deserve to be put extensively to the test of experience. These are Cold and Chloroform. Of cold I can speak favorably from my own experience; I have tried it by the application of ice in oxgullets to the spine, taking care to renew them frequently. * * * When cold fairly reaches the cord, its influence is shown by a marked depression of the action of the heart, which leads to general depression and debility. During the application of the bladders in this way, increased vigilance will be necessary in the administration frequently and at short intervals, of nutritious and stimulant substances."

Of the value of Chloroform and Ether, in the treatment of Tetanus and Tetanoid affections, Dr. Todd confessed that he had had no experience, but he strongly advised thier use from the results of experiments, which showed that these agents were capable of exercising a most powerful controlling influence over the polar state of the cord.

The Crimean War appears to have added little or nothing to our knowledge of the pathology and treatment of Tetanus.

The British Army during its service in Turkey and the Crimea, 1854–55–56, enjoyed a comparative immunity from this disease; only five cases occurred during the years 1854–5, viz: three at Scutari among the wounded, a fourth, apparently an idiopathic case, was fatal on the 13th December, 1854; and a fifth occurred in a patient who had been a month and a half under treatment for dysentery, complicated with frost-bite of the great toe, and ended fatally on the 20th February, 1855—while during the year 1855–56, only 24 cases occurred, viz: 23 in the Crimea, and one at home. One of these Crimean cases followed frost bite, another was thought to be idiopathic and due to exposure to cold, but this was questionable, as the symptoms were consequent on an injury of the foot; and the case which occurred in England, followed amputation for diseased bone, consequent on frost-bite.

This number is very far under what is believed to have occurred in any former campaign, being (exclusive of the idiopathic cases, and those following frost-bite) 0.2 per cent of the wounded. In the Spanish Legion, the proportion according to Mr. Alcock was 1.25 per cent. and in the Peninsula, the loss is known to have been very large from this cause, although the exact proportion cannot be ascertained. The causes of this immunity, notwithstanding the vast variety of wounds inflicted, the hardships and fatigue endured by the troops, and the defective and improper kind of food so long supplied to them, are not clear. The very simple mode of dressing wounds, universally adopted by British Surgeons, may not have been without its influence; and possibly also the universal practice of bringing the sides of the wounds in opposition by suture, position, etc., and not stuffing them with charpie, or other irritating substances, under the idea of favoring granulation, absorbing discharges, etc. The nearly total absence of marsh malaria, in the district occupied by the British troops is noteworthy in conjunction with this immunity; and it may be a question to what extent the employment of chloroform in operations has acted. Of the 23 Crimean cases, 21 terminated fatally; the mortality being 91 per cent. One of the recoveries took place under the exhibition of a mixture containing Chloroform, and of that drug by inhalation. He was often kept for hours more or less completely under its influence, and on one occasion for more than nine hours at a stretch.

Morphia was tried at the general Hospital, and as much as 10 grains given within 24 hours in 2 grain doses, in two cases which each lived long enough to allow the drug a fair trial; but only once, and then only in a very slight degree, did either of them exhibit any signs of narcotism, and both were fatal.

The only other recovery, was treated with Calomel and Opium to salivation; but the removal of the source of irritation from the sheath of the nerve, was more probably the cause of the abatement of the symptoms. Non-suppuration of the wound would not appear to have been a cause of the disease; indeed in some of the cases suppuration was remarkably profuse, and in many, even after the advent of the disease, the wounds looked healthy. The practice of large bleedings as a means of cure is, so far as they go, negatived by these cases. In no less than three the disease followed hæmorrhage, and in one of these, the bleeding had been very profuse. The average period in the Crimean cases, before tetanic symptoms was 8½ days from the date of the receipt of the injury, and the average duration of these symptoms before death closed the scene, 3½ days.—*Medical and Surgical History of the British Army, which served in Turkey and the Crimea, during the war against Russia, in the years 185¼–'55–'56.* Vol. ii, pp. 279–285.

Tetanus was of comparatively rare occurrence during the recent American Civil War, 1861–'65, in the Confederate Army. Thus in the Field and Hospital Reports for 1861, in 1750 cases of wounds of different characters, there were 13 cases of tetanus—0.75 per cent., or one of tetanus in 134 cases of wounds. Of these only three are reported as having ended fatally, giving a ratio of 23 per cent. mortally; or one death in four cases;—a result which clearly proves the inaccuracy of the earlier reports. In 1862, the consolidated reports from hospitals, presented 45,974 cases of wounds, and only 53 cases of tetanus—0.11% or one case of tetanus in 867 cases of wounds. Of these 53 cases, 28 terminated fatally—52.8 per cent.; about one death in two cases:—a much larger percentage of mortality than in 1861, but still, there is reason to believe much below the truth. Tetanus was doubtless of more frequent occurrence in the Confederate hospitals than would appear from the reports, as it is well known, that cases were generally reported under the term *Vulnus Sclopeticum*. No provision for the accurate report of *Supervening diseases* was made upon the official Field and Hospital Reports, until near the close of the war In the *Special Reports* of gun-shot injuries, involving tetanus, covering the whole period of the war, up to the end of 1863, and which were evidently drawn up with great care, only 66 cases were recorded; and of these, six only recovered, giving in the Confederate Army, a mortality of nearly 91 per cent. The relative mortality of the cases of Tetanus occurring amongst the Confederate Soldiers, appears therefore to have been almost precisely that of the British during the Crimean war. Assuming then, that these constitute the entire number of undoubted cases of tetanus, which occurred in the whole number of gun-shot wounds, up to the end of 1863 (56,775); we have the proportion of one case of Tetanus, to every 860 cases of gun-shot wounds.

In the United States service, during the Civil War of 1861–1865, 363 cases of Traumatic Tetanus were recorded. The proportion to the total number of wounds does not appear to be larger than in the Confederate service. It must be borne in mind, however, that the Confederate statistics given above relate only to 1861, 1862 and 1863, and do not include those of 1864 and 1865, which appear to have been either captured or destroyed at the time of the fall of the Confederate government.

Of the total number of cases of Traumatic Tetanus reported in the Federal service, 336 terminated fatally; of the 27 recoveries reported, the disease is said to have of the *so-called* "chronic form," in 23; in the remaining four cases, the symptoms very grave. In two, recovery took place under the use of opiates and stimulants; two, after amputation of the wounded part. In the Federal service there was only recovery in every 14.2 cases; and 92 per cent. of the cases terminated fatally, which very nearly equal to the mortality in the Confederate armies, viz: 91 per cent.

It is very evident, that during the Civil War of 1861–1865, in both the ern and Northern Armies, treatment had little or no influence in lessening the of mortality.

In the Federal service, the great majority of cases were treated by the free use Opium combined with stimulants, and concentrated nourishment. Chloroform inhalations were very generally employed during the paroxysms of spasmodic contractions. Sub-cutaneous injections of the salts of morphia and atropia were frequently Cathartics, Quinine, Camphor, Cannabis Indica, Bromide of Potassium, Strychnine, Belladonna and Aconite, are mentioned amongst the remedies used. Cups, blisters, turpentine, stupes and ice were among the applications made to the spine; and fomentations with Opium or tobacco, were in some cases applied to the wound. Amputations, the division of nerves and the extirpation of neuromata in stumps, were the surgical measures sometimes employed. The value of Nicotine of the Calabar bean, and Curare, as curative agents in Tetanus, was not tested. According to H. Demme, twenty-two cases of Traumatic Tetanus treated with Curare, eight recovered. (Circ *No. 6, War Department, Surgeon General's Office, pp. 41, 42.*

No light appears to have been thrown upon the pathology or treatment of Traumatic Tetanus, by the surgeons of either the Confederate or Federal Armies, during the most bloody gigantic and protracted Civil War.

Chloral Hydrate is at the present time *on trial*, as a remedy in Traumatic Tetanus and convulsive diseases generally, and thus far, the results of its employment have on the whole been favorable.

Dr. William MacLeod, Deputy Inspector General of Hospitals and Fleets, remarks with reference to the action of Hydrate of Chloral in Paralysis of the Insane and other forms of Insanity, that the facts which he had observed forced him to conclude:

1st. That in Paralysis of the Insane, when the patients are destructive and violent, the judicious administration of Chloral acts as an excellent hypnotic by night, and soothing agent by day.

2d. That under its action the patients have been free from destructive habits, and have gained in weight and strength.

3d. That in one case as much as 2,810 grains were taken during ninety-five days, the average taken being 30 grains, with no bad symptoms. In a second case, as much as grains, were taken during 122 days, being at the rate of 22 grains daily; when the patient gave evidence of prostration. A third patient took 2,380 grains during eighty days, the daily average being 20 grains, with no bad symptoms. A fourth patient took 1,362 grains during sixty-seven days, the average being 20 grains daily, with no bad symptoms. A fifth patient took 510 grains in twenty-four days, giving a daily average of 25 grains, with no bad symptoms.

4th. That under it the action of the bowels and bladder have improved.

5th. That in no case has there been a refusal of food; on the contrary, the appetite of paralytic patients increased.

6th. That patients suffering from abnormal sensation, derived much benefit from it.

7th. That in patients subject to hallucinations on hearing, with suicidal tendencies, it cut short the hallucinations.

8th. That in patients liable to hallucinations of hearing, and under their influence become noisy and excited, it has produced calm.

9th. That in patients with a propensity periodically to maim and hurt themselves, disease has passed away under the influence of Chloral. * *

10th. In certain cases of melancholia, benefit was derived from its administration, convalescence advanced. * *

11th. That the greater the disorganization of the brain and cord, (as judged by the symptoms, and especially by thermometric observations) the sooner does the system come the Chloral action. *Practitioner*, Aug., 1870.

Dr. John B. Tuke, has used Chloral very frequently of late in chronic cases of Insanity, in which violent outbursts of excitement occur, and invariably with good results. The insomnia of climacteric insomnia melancholy, is much relieved by a half drachm to a two scruple dose at bedtime. According to Dr. Tuke, the advantages of Chloral over all other hypnotics are: 1st. That it is more uniformly certain in its action. 2d. That it has no depressing influence. 3d. That it does not cause constipation. 4th. That it does not produce nausea. 5th. That its effects are more lasting. Dr. Tuke believes it to be the most valuable means of producing sleep, which has yet been introduced into the pharmacopia of the asylum physician. The only difficulty is to ascertain the exact dose for each case; but this is obviated by beginning with half drachm doses, and increasing them by ten grains, until the limit is found. *Lancet*, 1870, p. 443.

The preceding results are of great interest in their bearing on the use of this drug in Traumatic Tetanus, especially as they demonstrate that it may be used, continuously during considerable periods of time, without serious injury to the digestive or nervous ystems.

Dr. A. Ballantyne, (Lancet, October, 1870, p. 545), reports a case of Traumatic Tetanus, in a male aged 34 years, which supervened a fortnight after an injury of the left thumb at the base of the nail, by a thorn; and which recovered under the use of large and repeated doses of Chloral. This, although the ninth, was the only case of Traumatic Tetanus which Dr. Ballantyne had seen recover, although the temperature was 103°, upon the third day, and the extent, frequency and severity of the spasms, and the intensity and length of the diaphragmatic spasm, and the persistent rigidity of the thoracic and abdominal muscles, were as great as in his fatal cases. In giving the Chloral in this case, Dr. Ballantyne observed that the patient was less rapidly affected by it, as the doses were repeated, and that the first dose of one drachm had the most marked effect, reminding one very much of the rapid effect of chloroform in cases of severe and protracted labor, when the patient is much exhausted. The congestion of the conjunctiva was very great during the exhibition of the remedy, and continued some days after the doses were much lessened, In all, the patient had six ounces and a quarter of Chloral, during the three weeks, on an average of two to two and a half drachms per diem. After the eighth day, the Chloral was sometimes intermitted for several hours; but when more than six hours elapsed, the symptoms invariably became more intense, and the patient required a larger dose, more frequently repeated, during the next eight or twelve hours. Not unfrequently an extra half drachm of Chloral was given in addittion to those noted in the report for some specially severe time of suffering.

Mr. Berkett, (Lancet, September 24th, 1870, p. 434), reports a case of Traumatic Tetanus, cured in ten days, treated with Chloral Hydrate. Mr. Eager, (Lancet, March, 1871, p. 157), reports a case of Traumatic Tetanus, in which, although the Chloral hydrate was not ultimately successful, it undoubtedly afforded the patient great relief and comfort by procuring sleep, and for a time it certainly reduced the severity of the tetanic spasms. In another fatal case of Traumatic Tetanus, reported by Mr. Tyrrell, (Lancet, May, 1871, p. 265), although as in the case of Mr. Eager, the administration of the Chloral Hydrate did not save the patient's life, it certainly rendered the progress of the disease less painful by procuring sleep. This patient took 770 grains of Chloral in eleven days. In a case of Idiopatic Tetanus, reported by Mr. Harry Leach, of the Dreadnaught Hospital, (Lancet, September 24th, 1870, p. 435), the Chloral Hydrate was administered in drachm doses every three hours, and chloroform administered by inhalation during the same space. Although this case terminated fatally as is commonly the case, the chloral and chloroform greatly mitigated the severity of the spasms, and induced quiet, genuine sleep. A case of Idiopathic Tetanus has been successfully treated with chloral hydrate, by Mr. George Thompson, (Lancet, April, 1871, p. 19), In this case the drug was used in gradually increasing doses, from thirty to sixty grains. The effect of the Chloral in giving comfort and relief to the patient was very noticeable in this case, and the patient frequently begged for his draught.

Mr. C. Macnamara (The Practitioner, September, 1871), states, that he has treated since September 1st, 1870, *ten* consecutive cases of tetanus, in the Chandine Hospital, with the Hydrate of Chloral, alone. The quantity administered, varied from forty to one hundred and sixty grains per diem, according to the severity of the symptoms and age of the patient; but after a little experience of the effects of Chloral, it seemed to Mr. Macnamara, that it had no specific influence over the tetanic spasms; nevertheless, he believes that there can be no doubt, that even in the most severe cases of tetanus, this drug has the power of sending the patient off into a deep sleep, and thus for the time being, of preventing tetanic spasms; but in several instances it appeared as if the Hydrate of Chloral, by thus keeping back the tetanic energy, rendered it more concentrated; after deep sleep from chloral, the spasms, sometimes returning with such violence as speedily to destroy the patient. Of the ten cases treated exclusively with chloral, seven were instances of Traumatic Tetanus, and only one of them recovered; two cases of Idiopathic Tetanus, were thus treated, one of them recovered, as also did a case of the disease, occurring fifteen days after child-birth. Dr. Macnamara, says:

> "My experience thus far, has led me therefore, to conclude that I was hardly justified in trusting to the chloral alone, in the treatment of some cases of this disease; as an hypnotic. it seemed invaluable, but we must, if possible, do something more than put our patients to sleep in the management of bad cases of tetanus; and although the calabar bean possesses an influence, infinitely short of being a specific in this disease, nevertheless, the extract of Physostigma, if judiciously employed, has, I think, a salutary influence on some cases of tetanus."

The conclusions which Mr. Macnamara, has formed as to the general prognosis, are that:

> "We should be mainly guided by the temperature of the patient's body; so long (I am referring to the natives of India), as the temperature of the body is below 100°.F. I would give a favorable prognosis; and I would treat such a patient, by giving him as much milk and arrow-root as he could take, with a little wine and soup from time to time; and for an adult, forty grains of hydrate of chloral at bed-time. If the temperature of the patient's body however, (especially in the morning), rises to 101°, there is danger to be apprehended. Should the temperature rise suddenly from 99° or 100°, to 102°, the patient is in imminent danger, and I have seen few cases of tetanus recover after the temperature of the body has risen to 103°. In these cases however, we should resort to the extract of calabar bean, and hydrate of chloral at bed-time, and we may do so with some hope of success, provided the temperature keeps under 103°, and the muscles supplied from the spinal nerves are chiefly implicated; but if the muscles directly under the influence of the medulla are involved, and the temperature of the patient's body reaches 103° and upwards, we should relieve his terrible agony with hydrate of chloral, but can have but faint hopes of his recovery. After death from tetanus, the temperature from the body rises rapidly to about 107° F."

Dr. J. A. Beck, (St. Louis Medical Journal, June 18th, 1872), gives a summary of thirty cases of tetanus treated with the Hydrate of Chloral, in which the results are far more favorable than those obtained by Mr. Macnamara; viz: sixteen were cured and fourteen died. Successful results in tetanus, with the Hydrate of Chloral have also been recorded by Dr. Thomas, (Richmond and Louisville Medical Journal, November, 1872), Dr. A. G. Lawrence, (Lancet, March 4th, 1871), Dr. S. Baruch, (Richmond and Louisville Medical Journal, January, 1873, p. 1), Dr. Lavo, (Annali Universalidi, February, 1872), and others. Successful cases have been reported by several physicians, in which the Chloral Hydrate was given in conjunction with large doses of Bromide of Potassium.

In the following table I have consolidated from various sources, the reports of cases illustrating the results of the various methods of treating Tetanus.

Table showing the Age, Sex, Nature of Injury, Results and Methods of Treatment in Four Hundred and Twenty Cases of Tetanus: Consolidated by Joseph Jones, M. D., from the Recorded Observations of various Physicians and Surgeons.

No. of Case	Age	SEX.	NATURE OF INJURY.	APPEARANCE OF SYMPTOMS. DAYS.	RESULT AND IN WHAT TIME AFTER DAYS.	AUTHORITY.	TREATMENT AND REMARKS.
61	26	Male	Swelling of Fauces	6th day..	Fatal 5th day....	John Baptist Morgagni, seat and causes of diseases...............	Not stated.
62	15	"	Blows upon back and chest.....	4th day..	Fatal 6th day.....	Morgagni...............................	Not stated.
63	22	"	Laceration of Integuments of left heel	4th day..	Fatal	Morgagni..............................	Not stated.
64	...	"	Wound of wrist of left arm with saw..............................	3d day...	20th day Cured....	John Rotheram. Cullen's first lines..................................	Bleeding; Opium. Application of Emollient poultices and Tincture of Opium.
65	...	"	Compound fracture of arm......	14th day	Fatal 6th day.....	John Hunter..........................	Two grains of Opium every two hours. Bark and Opium. Bled on fifth day.
66	...	"	....	....	Fatal	John Hunter..........................	Three grs. opium every ½ hour. Opium had no effect.
67	...	"	....	....	Fatal	John Hunter..........................	Acetate of Lead in Pill.
68	...	"	....	....	Fatal	John Hunter..........................	Assafœtida, Opium and Bark in large quantities.
69	...	"	Gunshot wound of left part of thigh..................................	9th day..	Fatal 3d day.....	Baron Larrey..........................	Actual Cautery, Opium, etc.
70	...	"	Gunshot wound of calf of leg...	9th day..	Fatal 5th day.....	Baron Larrey..........................	Actual Cautery, Opium, etc.
71	...	"	Gunshot wound of right ear.....	9th day..	Fatal 7th day.....	Baron Larrey..........................	Actual Cautery, Opium, etc.
72	...	"	Gunshot wound......................	....	Fatal 3d day.....	Baron Larrey	
73	...	"	Gunshot wound......................	....	Fatal 4th day.....	Baron Larrey..........................	
74	...	"	Gunshot wound......................	....	Fatal 3d day.....	Baron Larrey..........................	
75	...	"	Gunshot wound......................	....	Fatal 4th day.....	Baron Larrey..........................	

OBSERVATIONS OF VARIOUS PHYSICIANS AND SURGEONS.—Continued.

No. of Case	Age......	SEX.	NATURE OF INJURY.	APPEARANCE OF SYMPTOMS. DAYS.	RESULT AND IN WHAT TIME AFTER DAYS.	AUTHORITY	TREATMENT AND REMARKS.
76	...	Male	Gunshot wound......................	....	Fatal 5th day.....	Baron Larrey........................	
77	...	"	Injury of knee by fall	5th day..	Fatal 7th day.....	Baron Larrey........................	Caustics to Wound; Opium. Cooling and Anodyne drinks; Purgatives, etc.
78	...	"	Gunshot wound......................	....	Fatal	Baron Larrey........................	Opium, Warm Baths. Caustic Applications to Wound.
79	...	"	Gunshot wound......................	....	Fatal	Baron Larrey........................	Opium, Warm Baths, Caustic, etc.
80	...	"	Gunshot wound......................	....	Fatal	Baron Larrey........................	Opium, Warm and Cold Baths, Caustics, etc.
81	...	"	Gunshot wound......................	....	Fatal	Baron Larrey........................	Opium, Warm and Cold Baths, Caustics, etc.
82	...	"	Gunshot wound......................	....	Fatal	Baron Larrey........................	Opium, Warm and Cold Baths, Caustics, etc.
83	...	"	Gunshot wound......................	....	Fatal	Baron Larrey........................	Opium, Warm and Cold Baths, Caustics, Cathartics.
84	...	"	Gunshot wound......................	....	Fatal	Baron Larrey........................	Opium, Warm and Cold Baths, Caustics, Cathartics.
85	...	"	Gunshot wounds of leg and arm	9th day..	Fatal 6th day.....	Baron Larrey........................	Opium, Warm and Cold Baths, Caustics, Cathartics, Emollient Applications, Cathartics.
86	...	"	Gunshot wound of right arm...	25th day	Recov'ed 26th day	Baron Larrey........................	Removal of Broken Bones, Opium and Camphor in large doses, Emollient Applications.
87	...	"	Gunshot wound of leg............	7th day..	Recov'ed 3d day...	Baron Larrey........................	Bloodletting, Alcohol and Ether, Opium and Emollient Applications.
88	...	"	Fish bone in fauces................	13th day	Recov'ed 6 days....	Baron Larrey........................	Sulphuric Ether in large doses, Opium and Castor, Nitrate of Potassa.
89	...	"	Amputation of right leg.........	24th day	Recov'ed 26th day	Baron Larrey........................	Opium and Antispasmodics. Large Blister over Stump.
90	...	"	Amputation of arm...............	9th day..	Recov'ed 3 days....	Baron Larrey........................	Opium and Camphor, Cantharides applied to wound.
91	...	"	Gunshot wound of left foot.....	12th day	Recov'ed 4 weeks..	Baron Larrey........................	Opium, Tobacco, and finally Amputation. Amputation afforded immediate relief.
92	...	"	Gunshot wound of leg...........	....	Fatal 3rd day.....	Baron Larrey........................	Amputation produced temporary calm, but symptoms returned in twelve hours, and patient died three days after amputation.
93	...	"	Gunshot wound of right arm...	8th day..	Recov'ed	Baron Larrey........................	Division of Injured Nerves, Opium, Anodyne Liniment, Emollient Enemata.

94	...	Male.	Amputation of right thigh......	8th day..	Recov'ed 60 days..	Baron Larrey......	Division of Ligature of Femoral Artery. Opium, Camphorated Liniment to surface of Body. Epispastic Ointment to wound.
95	...	"	Amputation of left thigh.........	5th day..	Recov'ed	Baron Larrey.........................	Opium, Actual Cautery, as last resort; Cautery afforded relief.
96	...	"	Gunshot wound of scapula......	....	Recov'ed 60 days..	Baron Larrey.........................	Opium, Actual Cautery applied to whole surface of Stump.
97	...	"	Gunshot wound of calf of leg..	....	Recov'ed	Baron Larrey.........................	Opium, Actual Cautery.
98	...	"	Amputation of index finger of right hand.........................	....	Recov'ed	Baron Larrey.........................	Div. of Ligature and Opiates gave no relief. The actual cautery was applied and the symptoms rapidly disapp'ed
99	...	Male	Gunshot wound of shoulder joint and amputation...........	....	Recov'ed 90 days..	Baron Larrey.........................	Opiates and Epispastics to the wound, of no avail; Actual Cautery effected rapid cure.
100	30	"	Amputation of fore and middle fingers of right hand...........	12th day	Fatal 3rd day.....	Duncan McArthur, Med. Chir., Trans. vii..........................	Opium, Frictions with stimulating liniments, Warm Baths.
101	30	"	Amputation of foot................	13th day	Fatal 8th day.....	McArthur..............................	Calomel Opium, Antimony Bloodletting, Camphor, Purgatives.
102	...	"	Amputation of arm at shoulder joint	12th day	Fatal 2d day.....	McArthur..............................	Opium and Warm Baths.
103	...	"	Wound of thigh by splinter.....	23d day..	Recov'ed 9th day..	Gilbert Blane, Diseases of Seamen, p. 556.........................	Opium and Warm Baths.
104	...	"	Compound comminuted fracture of humerus by splinter..	6th day..	Recov'ed 5 days...	Gilbert Blane.........................	Plaster composed of twelve ounces of Opium, moistened with Tincture of Thebaica, applied to Jaws.
105	...	"	Injury of leg...............	....	Fatal	James Currie, Medical Reports, pp. 105–133........................	Cold Baths. Opium and Wine.
106	...	"	Injury of jaw	....	Recov'ed	James Currie.........................	Cold Baths, Opium and Wine.
107	...	....	....	....	Fatal	James Currie.........................	Cold Baths Opium and Wine.
108	...	....	....	....	Fatal	James Currie.........................	Cold Baths, Opium and Wine.
109	...	"	Wound of hand......................	....	Recov'ed 42 days..	James Currie.........................	Opium, Warm and Cold Baths produced no good effects. Port wine was given in large quantities with benefit. The patient took in forty-two days one hundred and ten Quarts of Port Wine.
	4	"	Wound of leg.........................	15th day	Cured 50 days..	James Currie.........................	Twelve grains of Opium, and 1¼ Quarts of Port Wine were administered daily. In 50 days took 270 grains of Opium; and 18 fluidounces of Tinct. of Opium were applied externally. Affusions of Warm Water.

OBSERVATIONS OF VARIOUS PHYSICIANS AND SURGEONS.—Continued.

No. of Case	Age	SEX.	NATURE OF INJURY.	APPEARANCE OF SYMPTOMS. DAYS.	RESULT AND IN WHAT TIME AFTER DAYS.	AUTHORITY.	TREATMENT AND REMARKS.
111	...	Male.	Splinter under nail of finger	10th day	Recov'ed 50 days	James Currie	Tincture of Opium and Madeira Wine. Five bottles of wine per day. In twenty-eight days, the patient took one hundred and forty bottles of wine, several gallons of Brandy, and five and a half fluidounces of Tincture of Opium. During the same period twenty seven fluidounces of Laudanum were used in external embrocations.
112	28	"	Gunshot wound of hand	4th day	Recov'ed 14 days	Benjamin Travers. Further Inquiry Constitutional Irritation, p. 290	Complete relief of the symptoms followed incision of fore-arm.
113	...	"	Wound of integuments of right buttock	12th day	Recov'ed	B. Travers	Division of Integuments, and evacuation of matter.
114	22	"	Compound fracture of tibia and tarsus	7th day	Fatal	B. Travers	
115	18	"	Amputation of two middle fingers from gunshot wound	10th day	Fatal 3rd day	B. Travers	Extract of Belladonna, one to three grains every four hours. Calomel as purgatives; and Clysters.
116	...	"	Compound fracture of fore arm	10th day	Fat. 12th day	B. Travers	Purgatives, Mercurial Ointment.
117	...	"	Amputation of middle finger	1st day	Fatal 4th day	B. Travers	Belladonna, Wine of Colchicum and Purgatives freely administered.
118	...	"	Fracture of thigh	4th day	Fatal 3 days	B. Travers	On examination after death, it was found that a spicula of bone had transfixed the vastus externus.
119	...	"	Compound fracture of left leg	21st day	Fatal 6 days	B. Travers	
120	37	Fem'le	Compound fracture of right leg	3d day	Fatal 18th day	B. Travers	

121	48	Male.	Rusty nail penetrated sole of foot	7th day	Fatal 9th day	B. Travers	Division of Plantar Apeneurosis, Blister over Occiput and Spine. Extract of Belladonna, twenty grains in twenty-four hours.
122	40	"	Fracture of little finger	9th day	Fatal 2 days	B. Travers	
123	...	"	Amputation of arm	....	Fatal 2 days	B. Travers	
124	...	"	Puncture of foot with rusty nail	7th day	Fatal 3rd day	B. Travers	Travers records five other fatal cases of Traumatic Tetanus.
125	14	Fem'le	Lacerated wound of wrist and hand	12th day	Recov'ed 21st day	B. Travers	Infusion of Tobacco by Enema, Opium and Purgatives. Recovery attributed to Tobacco.
126	42	"	Puncture of knee	....	Recov'ed	B. Travers	Infusion of Tobacco by Enema, Purgatives. Recovery attributed to Tobacco.
127	40	Male.	Contused knee	9th day	Fatal 6th day	T. B. Curling. Treatise on Tetanus	Purgatives, Opiate Injections.
128	16	"	Laceration and contusion of hand	13th day	Fatal 15th day	Curling	Purgatives, Opium, Stimulants.
129	16	"	Blow on back of neck	1st day	Fatal 2d day	Medical Gazette, vol. i, p. 645.	Cut Cups to back of Neck, Croton Oil, Opium, Belladonna
130	25	"	Lacerated wound of little toe	10th day	Fatal 14th day	Medical Gazette, vol. i, p. 645.	Purgatives, Mercury, Opium, Antimony, Musk, Turpentine, Belladonna.
131	24	"	Lacerated wound of sole of foot caused by iron spike	11 days	Fatal 2d day	Medical Gazette, vol. ii, p. 343.	Cold Affusion, Sulphate of Quinine, Hydrocyanic Acid.
132	...	"	Fore finger wounded with a blunt piece of tin	12 hours	Cured in a few hrs.	Medical Gazette, vol. ii, p. 141.	Amputation, Bleeding, Tobacco, Opium.
133	21	"	Wound in sole of the foot with a nail followed by an abscess	16th day	Fatal 10th day	Medical Gazette, vol. vi, p. 830.	Bloodletting, Leeches, Opium, Musk, Mercurial friction.
134	33	"	Slight wound of foot by a nail.	30 days	Fatal 18 days	Medical Gazette, vol. vii, p. 312.	Venesection, Leeches, Opium, Vapor Baths.
135	70	"	Contusion of right hand, with fracture of three metacarpal bones	10th day	Fatal 2d day	Medical Gazette, vol. vii, p. 383.	Blisters, Turpentine Injections, Carbonate of Iron.
136	21	"	Lacerated wound of integuments of leg, closed with sutures	16th day	Fatal 7th day	Medical Gazette, vol. vii, p. 828.	Opium.
137	15	"	Wound of foot with rusty nail.	11 hours	Recov'ed 3 days.	Medical Gazette, vol. xi, p. 623.	Division of the Nerve, Opium, Camphor, Venesection.
138	10	"	Compound fracture of both bones of right leg	9th day	Fatal 2d day	Medical Gazette, vol. xii, p. 15.	Nerve divided, Croton Oil, Opium, Antimony, Tobacco, Cautery.
139	43	"	Fractures of the left leg, crista of the ileum and great toe of right foot, with lacerations	10th day	Recov'ed 30 days	Medical Gazette, vol. xii, p. 799.	Bark Opium, Carbonate of Iron.
....		"	Foot wounded with a nail	14th day	Recov'ed 6 weeks	Medical Obs. and Inq., i, p. 51.	Venesection, Musk, Opium, Valerian.

OBSERVATIONS OF VARIOUS PHYSICIANS AND SURGEONS.—Continued.

No. of Case	Age	SEX.	NATURE OF INJURY.	APPEARANCE OF SYMPTOMS. DAYS.	RESULT AND IN WHAT TIME AFTER DAYS.	AUTHORITY.	TREATMENT AND REMARKS.
141	20	Male.	Contused wound of the finger	30 days	Recov'ed 6 weeks	Med. Obs. and Inq., ii, p. 382	Venesection, Blister, Musk, Bark, Camphor, Valerian, Amputation.
142	23	"	Amputation at the shoulder joint on account of gunshot wound of the arm	26th day	Recov'ed 30 days	Med. Obs. and Inq., iii, p. 320	Musk, Opium.
143	22	"	Contusions about the head and body	....	Recov'ed in a week	Med. Obs. and Inq., vi, p. 148	Cold Affusion.
144	25	"	Wound of sole of foot with rusty nail	3d day	Recov'ed 4 days	Med. Obs. and Inq., vi, p. 155	Cold Affusion, Opium, Bark.
145	35	"	Contused wound on the forehead	20th day	Recov'ed 5 weeks	Med. Chir. Trans., vol. ii, p. 284.	Mercury, Colocynth, Gamboge, Scammony, Opium, Stimulants.
146	...	"	Laceration of great toe	21 days	Fatal 7th day	Med. Chir. Trans., vol. vi, p. 93.	Venesection, Mercury, Dover's Powders, Tobacco.
147	30	"	Amputation of two fingers	11 days	Fatal 7th day	Med. Chir. Trans., vol. vii, p. 468	Opiate Injections.
148	30	"	Amputation of the leg	13th day	Fatal 8th day	Med. Chirur. Trans., vol. vii, p. 470	Venesection, Warm Bath, Mercury.
149	...	"	Amputation at the shoulder joint	12th day	Fatal 2d day	Med. Chirur. Trans., vol. vii, p. 473	Warm Bath, Opium.
150	19	"	Slight wound of the left hand	18th day	Recov'ed 24 days	Med. Chirur. Trans., vol. xi, p. 384	Venesection, Warm Baths, Purgatives, Mercury, Dover's Powders.
151	...	"	Compound dislocation of the great toe	14th day	Recov'ed 10 days	Med. Chirur. Trans., vol. xv, p. 163	Turpentine, Carbonate of Iron, Musk, Stimulants.
152	44	"	Right thumb jammed between two pieces of wood	8 days	Recov'ed 25 days	Med. Chirur. Trans.	Turpentine, Carbonate of Iron.
153	13	"	Foot torn by machinery	9th day	Recov'ed 42 days	Dublin Hospital Reports, vol. iii, p. 357	Purgatives, Turpentine Injections, Leeches, Tobacco.
154	14	"	A bite by a dog in the leg	14 days	Recov'ed 30 days	Bright's Medical Reports, vol. ii, p. 558	Purgatives, Mercury, Opium, Leeches, Tonics.
155	15	"	Both heels lacerated and humerus fractured	7th day	Fatal 40 hours	Bright's Medical Reports, vol. ii, p. [illegible]	Musk, Purgatives, Opiate Injections.

			tum and abdomen	10th day	day	Swan, on Tetanus, p. 77	Opium, Musk.
159	37	"	Foot wounded with a spike	21 days	Fatal 6th day	Swan, on Tetanus, p. 82	Turpentine, Mercury, Opium. Amputation.
160	17	"	Severe contusion of left heel	5 days	Fatal 20 days	Morgagni, de Causis liv., 49	
161	...	"	Finger pierced by splinter	10 days	Recov'ed 56 days	Currie's Medical Reports, i, 169.	Opium, Stimulants, Cold Affusion.
162	40	"	Amputation of leg	5th day	Fatal 2d day	Parry's cases of Tetanus	Venesection.
163	5	"	Lacerated wound of instep, great toe fractured	8th day	Fatal 2d day	Parry's cases of Tetanus	Opium, Cold Affusion, Antimony.
164	30	"	Laceration of the integuments over gastrocnemius muscle	20 days	Recov'ed 10 days	Parry's cases of Tetanus	Opium, Mercury.
165	50	"	Slight wound of nose	......	Recov'ed 10 days	Lawrence, Lect. Med. Gaz., v, 549	Venesection, Purgatives, Opium.
166	18	"	Slight contusion of toe	10 days	Fatal 3rd day	Edin. Med. Chir., Trans. ii, 360.	Purgatives, Tobacco.
167	12	"	Punctured wound of the thumb	4 days	Recov'ed 30 days	Edin. Med. Chir., Trans. ii	Purgatives, Tobacco.
168	22	"	Slight wound of head	7th day	Fatal 8th day	Jamaica Physical Journal, 1834.	Mercury, Opium.
169	...	"	Wound of thumb with splinter.	9th day	Fatal 5th day	Jamaica Physical Journal	Venesection, Tobacco.
170	28	"	Great toe punctured with nail	14th day	Fatal 40 hours	Jamaica Physical Journal	Tobacco.
171	30	"	Wound of right hand by pistol ball	7th day	Recov'ed 30 days	Edin. Med. and Surg. Journal, vii, 14	Opium, Cold Baths, Digitalis, Stimulants.
172	22	"	Gunshot wound of elbow joint.	16th day	Recov'ed 30 days	Edin. Med. and Surg. Journal, viii, 412	Venesection, Opium, Amputation, Warm Bath, Mercury.
173	20	"	Laceration and contusion of left foot	15th day	Recov'ed 42 days	Edin. Med. and Surg. Journal, xi, 198.	Opium, Warm Baths, Tobacco, Stimulants.
174	15	"	Lacerated wound of left leg	10th day	Recov'ed 21 days	Edin. Med. and Surg. Journal, xi, 316	Mercury, Opium, Stimulants, Tonics.
175	27	"	Wound in left leg	14 days	Recov'ed 42 days	Edin. Med. and Surg. Journal, xi, 422	Opium, Stimulants, Tonics.
176	20	"	Two musket shot wounds in left arm	30 days	Recov'ed 30 days	Edin. Med. and Surg. Journal	Opium, Stimulants.

OBSERVATIONS OF VARIOUS PHYSICIANS AND SURGEONS—Continued.

No. of Case	Age	SEX.	NATURE OF INJURY.	APPEARANCE OF SYMPTOMS. DAYS.	RESULT AND IN WHAT TIME AFTER DAYS.	AUTHORITY.	TREATMENT AND REMARKS.
177	25	Male.	A bite on the thigh	2d day	Recov'ed 14 days	Edin. Med. and Surg. Journal, xiii, 451	Purgatives, Opium, Mercury, Stimulants
178	8	"	Severe burn of right hand	10th day	Recov'ed 30 days	Edin. Med. and Surg. Journal, xviii, 394	Amputation.
179	...	"	Sole of foot wounded with a rusty nail	13th day	Fatal 20 hours	Edin. Med. and Surg. Journal, xviii, 38	Mercury, Opium, Camphor.
180	20	"	Contusion of Abdomen	17th day	Recov'ed 30 days	Edin. Med. and Surg. Journal, xviii, 191	Venesection, Opium, Blisters, Mercury.
181	14	"	Laceration of the hand	12th day	Fatal 10 days	Edin. Med. and Surg. Journal, xxi, 292	Amputation, Opium, Mercury.
182	15	"	Compound fracture of thumb	14 days	Recov'ed 14 days	Edin. Med. and Surg. Journal, xxiv, 277	Purgatives, Tobacco, Leeches, Mercury.
183	...	"	Gunshot wound in left arm	7th day	Fatal 30 hours	Edin. Med. and Surg. Journal, xxx, 21	Opium, Mercury.
184	16	"	Arm shot away by a cannon shot. Amputation at shoulder joint, 5 days afterwards.	21 days	Recov'ed 30 days	Edin. Med. and Surg. Journal, xxx, 28	Purgatives, Opium, Mercury, Stimulants.
185	14	"	Extensive wound on right leg, and slight wound on outer ankle of left leg	10 days	Fatal 12th day	Med. and Phys. Jour., xiv, 129.	Opium, Stimulants, Cantharides, Cold Affusion, Mercury.
186	16	"	Wound on the hip by a splinter	5th day	Fatal 4th day	Med. and Phys. Jour., xxi, 181.	Warm Baths, Mercury.
187	30	"	Right arm shot away. Amputation at shoulder joint	8th day	Fatal 2d day	Med. and Phys. Jour., xxi	Mercury.
188	18	"	Wounded on shoulder and back by splinters	8th day	Fatal 4th day	Med. and Phys. Jour., xxi, 409.	
189	...	"	Compound fracture of hand by grape shot	9th day	Fatal 3rd day	Med. and Phys. Jour., xxi, 446.	Mercury and Blisters.
190	...	"	Leg shot away. Amputation	9th day	Fatal	Med. and Phys. Journal, xxi	Mercury.
191	...	"	Wound in groin by musket ball	8th day	Fatal 4th day	Med. and Phys. Journal, xxi	Blisters and Mercury.
192	29	"	Compound fracture of leg	10th day	Fatal 9th day	Med. and Phys. Jour., xxii, 120.	Mercury, Amputation.

					day..	Med. and Phys. Journal, xxii...	Amputation.
			hand	15th day	Fatal 2d day	Med. and Phys. Jour., xxii, 324.	Venesection, Opium, Mercury, Warm Bath.
196	23	"	Sole of foot wounded with rusty nail	8th day..	Fatal 5th day	Med. and Phys. Jour., xxii, 185.	Mercury, division of wounded parts.
197	...	"	Wound of great toe by hand saw	10th day	Recov'ed 56 days..	Med. and Phys. Jour., xxii, 396.	Opium, Warm Baths, Stimulants, Mercury.
198	46	"	Compound fracture of thigh	21 days..	Recov'ed	Med. and Phys. Jour., xxii, 479.	Mercury, Opium.
199	44	"	Laceration of hand and fingers	10th day	Fatal 2d day	Medical Quar. Review, iv	Mercury, Opium, Blisters.
200	13	"	Punctured wound of leg	9th day..	Recov'ed	Med. and Phys. Journal, xxxvii, 19	Purgatives, Opium, Mercury, Cold Affusion, Venesection, Stimulants.
201	49	"	Punctured wound of thumb	8th day..	Recov'ed	Med. and Phys. Journal, xxxvii, 23	Venesection, Purgatives, Opium.
202	58	"	Incised wound of back of hand.	21st day	Recov'ed 35 days..	Med. and Phys. Jour., xliii, 192.	Opium, Warm Bath, Camphor, Hyoscyamus, Venesection, Purgatives, Mercury.
203	50	"	Slight wound of finger	...	Recove'd 42 days..	Med. and Phys. Jour., xliii, 298.	Digitalis, Leeches, Antimony.
204	50	"	Wound of sole of left foot by a nail	10th day	Recov'ed 4 days...	Med. and Phys. Jour., xlvi, 538.	Venesection, Mercury, Purgatives, Warm Bath.
205	20	"	Incised wound extremity of finger	16th day	Recov'ed 35 days..	Med. and Phys. Jour., l, 446...	Opium, Purgatives. Blisters, Hyoscyamus.
206	20	"	Sole of foot wounded with rusty nail	5th day..	Fatal 2d day	Med. and Phys. Jour., lvi, 319..	Purgatives, Hydrocyanic Acid, Venesection.
207	14	"	Fracture of radius, and laceration of integuments of right leg	16th day	Recov'ed 7 days...	Med. and Phys. Jour., lxii, 220.	Purgatives, Leeches. Carbonate of Iron, Mercury, Opium, Antimony, Cold Affusion.
208	40	"	Fracture of ieg with slight laceration of integuments	6th day..	Fatal 2d day	Med. and Phys. Jour., lxvi, 42..	Mercury, Opium.
209	15	"	Legs, thighs, and arms scalded with hot water.	10th day	Fatal 6th day	Glasgow Medical Journal, ii. ...	Purgatives, Opium, Mercury.
210	17	"	...	7th day..	Fatal 3rd day	Glasgow Medical Journal, ii....	Leeches, Mercury, Amputation, Antimony, Acetate of Morphia.
211	45	"	Compound fracture of three fingers	10th day	Fatal 26 hours	Med. Chirur. Rev., x, 614..	Purgatives, Mercury, Opium, Blisters.
212	25	"	Slight wound of right leg	7th day..	Cured 24 days	Medical Transactions, iv, 29....	Dover's Powders, Purgatives, Tonics.
213	40	"	Lacerated wound above lelt elbow	5th day..	Fatal 40 hours	London Medical Reports, xiv, 1.	

OBSERVATIONS OF VARIOUS PHYSICIANS AND SURGEONS—Continued.

No. of Case	Age	SEX.	NATURE OF INJURY.	APPEARANCE OF SYMPTOMS. DAYS.	RESULT AND IN WHAT TIME AFTER DAYS.	AUTHORITY	TREATMENT AND REMARKS.
214	16	Male	Blow on cervical spine	3d day	Fatal same day	Dazille Observ., sur le Tetanos.	Venesection, Purgatives.
215	...	"	Compound fracture of leg	7th day	Fatal 3rd day		
216	28	"	Finger and left hand cut off by hatchet	2 hours	Fatal 12 hours	Diction. des Sciences Medicales.	Venesection, Warm Bath, Opium.
217	...	"	Sole of left foot wounded by nail	11 days	Fatal 9th day	Med. Facts and Obs., vii, 267	Cold Affusion, Tonics, Warm Baths, Electricity, Mercury.
218	15	"	Compound fracture of bones of thumb	6th day	Fatal 2d day	Trans. College Physicians, Ireland, iv, 275	Venesection, Purgatives, Opium, Cold Affusion, Mercury.
219	60	"	Slight wound on the ear and temple	7 days	Fatal 6th day	Trans. Col. Phys., Ireland	Purgatives, Tobacco, Opium.
220	42	"	Lacerated wound of thumb	8 days	Fatal 3rd day	Trans. Col. Phys., Ireland	Tobacco and Mercury.
221	24	"	Contusion and slight laceration on shin	21 days	Recov'ed 14 days	Trans. Col. Phys., Ireland	Venesection, Purgatives, Mercury, Antimony, Stimulants, Opium.
222	31	Fem'le	A cut on the thumb	4 days	Fatal 19 days	Dr. Bright's Medical Reports, ii, 575	Leeches, Opium, Antimony Mercury, Zinc.
223	28	"	Tendon of peroneus longus exposed in an ulcer pulled in dressing	1 hour	Recov'ed 2 days	Medical Gazette, ii, p. 384	Venesection Leeches, Warm Baths, Mercury, Morphia.
224	40	"	Lacerated wound of palm of left hand	11 days	Recov'ed 14 days	Medical Gazette, ii, p. 384	Opium, Mercury, Turpentine.
225	40	"	Cupping on temples	5 days	Recov'ed	Edin. Med. Chir. Trans., i, 184.	Purgatives, Tobacco.
226	...	"	Incised wound of hand and fingers	13th day	Recov'ed 42 days	Edin. Med. Chir. Trans.	Purgatives, Tobacco.
227	50	"	Compound fracture of leg	21 days	Recov'ed 35 days	Med. Chir. Trans., ii	Opium, Mercury.
228	23	"	Lacerated wound of finger, left hand	16th day	Recov'ed	Med. Obs. and Inq., i, 1	Blisters, Opium, Amputation.
229	22	"	Sole of left foot wounded with a thorn	21 days	30 days. Recov'ed	Edin. Med. and Surg. Journal, i, 294	Blisters, Mercury, Opium, Cold Affusion.

230	22	Fem'le	Toes frost bitten		Fatal 2 days	Parry's cases of Tetanus, 10	Opium, Mercury.
231	52	"	Wound in left cheek by arrow	2d day	Relieved 30 days	Med. and Phys. Jour., xxiv, 40.	Opium, Purgatives, Mercury, Antimony.
232	...	"	Laceration of integuments of right knee	18 days	Recov'ed 30 days	Med. and Phys. Jour., xliii, 95.	Venesection, Purgatives, Opium, Mercury.
233	24	"	Foot wounded by bit of glass	8th day	Fatal 5 days	Dr. Morrison's Treatise on Tetanus	Venesection, Mercury, Opium, Stimulants, Warm Bath.
234	18	"	Amputation of thigh	10th day	Recov'ed 21 days	Campet, Traité des Mal Graves, 18	Purgatives, Tobacco, Opium.
235	20	"	A cut on the metatarsus	10th day	Recov'ed 90 days	Campet, Traité des Mal Graves, 22	Venesection, Purgatives, Opium, Tobacco.
236	10	Male.	Gunshot wound of calf of right leg	5th day	Fatal 16 hours	T. B. Curling, Treatise on Tetanus	Purgatives, Opium, Tartar Emetic.
237	21	"	Fore finger of right hand injured by nail	21 days	Fatal 4 days	Curling	Purgatives, Opiate Injections.
238	30	"	Contusion of fingers of right hand	14 days	Recov'ed 21 days	Curling	Venesection, Opium, Calomel.
239	22	"	Compound dislocation of right great toe	10 days	Fatal 14 days	Curling	Opiate Injections, Stimulants.
240	42	"	Wound of right thigh by iron spike	9th day	Fatal 3rd day	Curling	Opium, Tobacco.
241	26	"	Blow on head	4th day	Fatal 9th day	Curling	Mercury, Opium, Tobacco.
242	19	"	Sole of left foot injured by nail	21 days	Recov'ed	Curling	Purgatives, Opiate Injections, Stimulants.
243	31	"	Compound dislocation of astragalus and os naviculare	7th day	Fatal 2d day	Curling	Hydrocyanic Acid.
244	15	Fem'le	Division of cicatrix of burn	21 days	Fatal 9th day	Mr. B. Cooper, Lancet, 1827, i p. 265	Purgatives, Tartar Emetic, Opium, Ether, Calomel, Hemlock Poultices, Warm Baths.
245	70	Male	Lacerated wound of skin	28 days	Fatal 10th day	Mr. Callaway, Lancet, 1827, 324.	Carbonate of Ammonia, Laudanum, Hoffmann's Anodyne
246	15	"	Lacerated wound of outer toes.	16 days	Recov'ed 12 days	Mr. Tyrrell, Lancet, 1827, 325	Oil of Turpentine, Calomel, Blisters, Opium.
247	30	Fem'le	Application of blister to left side	6 days	Recov'ed 15 days	J. Taylor, Lancet, 1828, 72	Venesection, Purgatives, Opium, Electricity.
248	37	Male.	Wound of thigh by spike	22 days	Recov'ed 14 days	Mr. B. Cooper, Lancet, 1825, 60.	Hydrocyanic Acid, Sulphate of Quinia, Opium, Ether, Turpentine, Enema, Purgatives.
9	30	"	Little finger crushed	8 days	Fatal 3rd day	Mr. B. Cooper, Lancet, 1825, 393	Opium, Opiate Injections, Mercury.
0	50	"	Wound of nose from a fall	10 days	Recov'ed	Mr. Lawrence, Lancet, 1830, 389	Croton Oil, Opium and Hyoscyamus. One drachm of Opium and Hyoscyamus administered at a dose.

OBSERVATIONS OF VARIOUS PHYSICIANS AND SURGEONS—Continued.

No. of Case	Age	SEX.	NATURE OF INJURY.	APPEARANCE OF SYMPTOMS. DAYS.	RESULT AND IN WHAT TIME AFTER. DAYS.	AUTHORITY.	TREATMENT AND REMARKS.
251	...	Male.	Compound dislocation of great toe	14th day	Recov'ed 10 days	Dr Elliotson, Lancet, 1829, 55.	Sub-Carbonate of Iron, in half ounce doses.
252	44	"	Right thumb mashed	14 days	Recov'ed 10 days	Dr. Elliotson, Lancet, 1829, 538.	Sub-Carbonate of Iron, Castor Oil, Turpentine Injections.
253	15	"	Small ulcer over right tendo-achillis	....	Fatal 4th day	Dr. Elliotson, Lancet, 1828, 760.	Sub-Carbonate of Iron and Turpentine Enema.
254	14	"	Fracture of right arm and laceration of right knee	15 days	Recov'ed 14 days	Mr. Mayo, Lancet, 1829, 729	Opium, Calomel, Croton Oil, Antimony, Leeches.
255	20	"	Laceration of index finger	4 days	Fatal 2 days	Mr. Vincent, Lancet, 1831, p. 62.	Opium, Croton Oil, Warm Bath.
256	12	"	Wound of sole of foot by rusty nail	3d day	Fatal 8th day	Mr. Lynn, Lancet, 1832, 715	Opium, Aperient Glysters.
257	18	"	Index finger crushed by piece of timber	9th day	Fatal 3rd day	Mr. Guthrie, Lancet, 1833, p. 388	Amputation of finger, Opium, Croton Oil, Turpentine.
258	35	"	Compound fracture of left leg	7th day	Fatal 4th day	Dr. Wallace, Lancet, 1836, 846.	
259	54	"	Wound of left great toe	11th day	Recov'ed 44 days	Dr. Wallace, Lancet, 1836, 547.	
260	3	"	Wound of integuments over knee joint	9th day	Fatal 2d day	Mr. W. Wallace, Lancet, 1836, 849	
261	11	"	Punctured wound, hollow of sole of right foot	9th day	Fatal 5th day	Mr. Wallace, Lancet, 1836, 849.	
262	30	"	Compound dislocation and laceration of fingers of right hand	8th day	Fatal 3d day	Mr. Wallace, Lancet, 1836, 580.	
263	47	"	Burn of sole of right foot	4 days	Fatal	Lancet, 1836, 34	Injection of three grains of Tartar Emetic into Median Vein of left arm. The action of the solution of Tartar Emetic was instantaneous. The pulse became small, and frequent; respiration accelerated; pupils contracted; the patient coughed and vomited; body covered with profuse sweat. The Tetanic Symptoms continued until Opisthotonos

264	18	Male.	Gunshot wound of left thigh	5 days	Fatal 21 hours	Lancet, 1836, p. 277	Opium, Calomel, Croton Oil, Mercurial Frictions.
265	11	Fem'le	Wound of sole of foot by a thorn	4th day	Recov'ed 4 days	Dr. Peacock, Lancet, 1836, 397.	Purgatives, Oil of Turpentine.
266	17	"	Wound of hand with rusty nail	few days	Recov'ed	Dr. Peacock, Lancet, 1836, 397.	Wound laid open, Oil of Turpentine.
267	40	"	Wound of thumb with sharp bone	...	Recov'ed	Dr. Peacock, Lancet, 1837, 640.	Purgatives, Oil of Turpentine.
268	42	Male.	Severe contusion and abrasion back of head	...	Fatal 30 hours	M. A. Eves, Lancet, 1838, 837	Opium, Bleeding, Camphor, Oil of Turpentine.
269	...	"	Moxa for cure of dysentery	...	Recov'ed 11 days	O'Shaughnessy, Lancet, 1840, 53	Extract of Hemp, two to three grains, every second or third hour.
270	...	Male.	Kick of horse	...	Relieved 17 days	O'Shaughnessy, Lancet, 1840, 541	Extract of Hemp; one hundred and thirty four grains of Extract of Indian Hemp were consumed.
271	25	Fem'le	Cut on left elbow	14 days	Recov'ed 26 days	O'Shaughnessy, Lancet, 1840, 540	Extract of Hemp, Purgatives.
272	29	"	Lacerated wound of outside of foot	16th day	Recov'ed 30 days	A. Eves, Lancet, 1841, 767	Opium, Extract Hyoscyamus, Camphor, Sulphuric Ether.
273	49	"	Wound of left arm	6th day	Fatal 36 hours	G. H. Smith, Lancet, 1841, 117.	Opium, Calomel, Muriate of Morphia.
274	29	"	Index finger of right hand shattered	immed'ly	Fatal 32 hours	J. B. Thomson, Lancet, 1841, 398	
275	18	Male.	Wound of head	15th day	Recov'ed 35 days	C. C. Higgins, Lancet, 1842, 152	Free Bloodletting, Opium.
276	...	Fem'le	Parturation, labor induced artificially by rupture of membranes	7th day	Fatal 2d day	Lancet 1838, 335, J. Finucane	Bloodletting, Opium, Assafœtida, Calomel, Enemas of Tobacco, Oil of Turpentine.
277	...	"	Gunshot wound of leg	...	Fatal	M. Matteucci, Lancet, 1838, 351.	Continuous Electric Current.
278	...	"	Lacerated wound of little finger	17 days	Recov'ed 9 weeks	Mr. Solly, Lancet, 1844, 163	Opium, Indian Hemp, Tobacco, Brandy, Turpentine, Blister over Spine.
279	28	"	Indolent ulcer of leg	...	Fatal	Mr. Solly, Lancet, 1844, 199	Indian Hemp.
280	17	"	Wound of left ear by stick	12 days	Fatal	Mr. Solly, Lancet, 1844, 194	Indian Hemp.
281	34	"	Wound of neck	...	Recov'ed 9 weeks	R. S. Hutchinson, Lancet, 1844 275	Extract of Belladonna, Croton Oil, 4 grains of Extract of Belladonna at each dose. Five grains of Extract of Belladonna were administered by Mr. Hutchinson, in another case which recovered. The system appears to acquire a tolerance of this remedy, and it is necessary gradually to increase the dose.

OBSERVATIONS OF VARIOUS PHYSICIANS AND SURGEONS—Continued.

No. of Case	Age……	SEX.	NATURE OF INJURY.	APPEARANCE OF SYMPTOMS. DAYS.	RESULT AND IN WHAT TIME AFTER DAYS.	AUTHORITY.	TREATMENT AND REMARKS.
282	…	Male	Severe laceration of upper portion of right thigh exposing femoral vessels …………………	12th day	Fatal 4th day….	H. G. Potter, Lancet, 1845, 36..	Indian Hemp, by mouth and by enema, in all four drachms and twelve scruples of extract administered. Tobacco by Injection, Calomel, Dover's Powders.
283	17	"	Lacerated wound of right hand	12th day	Fatal 12th day	J. W. Stapleton, Lancet, 1845, 317……… ……………… ………	Alcohol. Twenty-six hours having been occupied fruitlessly in the administration of Opiates and Antispasmodics, Blisters and Croton Oil, the symptoms increasing in gravity, jaws firmly locked, body resting on head and heels; six ounces of a mixture of equal parts of Alcohol and water were administered, and four fluidounces more in quarter of an hour. In twenty-five minutes, the patient for the first time, lay on his side in a tranquil sleep, with complete relaxation of muscles. On the eleventh day, the Alcoholic stimulus was withdrawn, and with a return of consciousness, the tetanic symptoms returned but with less violence, and disappeared when the alcohol was renewed. Patient suddenly expired in a spasm, on the evening of the twelfth day.
284	11	"	Blow with stick over loins……	4th day..	Recov'ed 10 days..	W. S. Preshaw, Lancet, 1846, 154…………… …………… ………	Wet Sheets, Cold Bath.
285	11	"	Lacerated wound of knee……..	8th day..	Recov'ed 60 days..	Mr. Hinton, Lancet, 1846, 246..	Mercury, Opium, local application of Aconite and Veratria; Wine of Antimony and Extract of Belladonna temporarily employed.
286	30	"	Kick of horse on cheek bone…	9th day..	Recove'd 35 days..	H. Sandwith, Lancet, 1846, 39.	Blister over Spine, Mercury, Venesection, Antimony, Aperients.

							Irritants to Spine, Nitrate of Silver, one-third grain every five hours.
288	24	Male.	Gunshot wound of left forearm.	21 days..	Recov'd 30 days..	W. B. Page, Lancet, 1846, 394.	Tincture of Aconite, three to five minims every two or three hours; Opium, Porter, Beef Tea.
289	...	"	Contused wound of great toe...	9th day..	Fatal 9th day.....	W. Newton, Lancet, 1846, 494..	Aconite, Tobacco and Morphia.
290	31	"	Foot crushed by wheel of wagon	6th day..	Fatal 24 hours.....	C. J. Gilb, Lancet, 1846, 141...	Croton Oil, internally and locally over spine, Enema of one fluidounce Tincture of Hyoscyamus, and one fluid-drachm Laudanum.
291	21	"	Fall on back	20 hours	Fatal 70 hours.....	Dr. Brady, Lancet, 1847, 517...	Inhalation of Ether, produced temporary relaxation of muscles and cessation of spasms; Blister along Spine, Mercurial Ointment, Opium and Calomel.
292	33	"	Lacerated wound of cornea.....	7th day..	Fatal 3rd day.....	G. Pollock, Lancet, 1847, 589...	Vapor of Ether. In a tabulated statement of ten other cases of Tetanus, admitted into George's Hospital, London, given by Mr. Pollock, only two recovered.
293	...	"	Ring finger of left hand cut off by machinery	5 days...	Recov'd 11 days..	R. L. Baker, Lancet, 1848, 610..	Chloroform by Inhalation, Blister to neck, and two grains of Calomel every two hours. The patient had lost the power of speech and deglutition, and was rigid with tetanic spasms. Chloroform was administered by inhalation; in about three minutes the muscles began to relax; for a short time he muttered incoherently, then answered two or three questions rationally, and finally sank into a sound sleep, free from spasms, and with the muscular system relaxed. The patient awoke in one hour, and the Chloroform was again administered with like results.
294	...	"	Amputation of great toe, and two adjoining toes	9th day..	Fatal 13th day	A. C. Selkirk, Lancet 1848, ii, 635	Chloroform by Inhalation, Mercury.
295	21	"	Sole of foot wounded by fish bone	19th day	Recov'd 24 days..	C. H. Smith, Lancet, 1848, 667.	Inhalation of Chloroform and Ether.
296	24	"	Wound of leg by scythe	23d day..	Recov'd 16 days..	O. Foulke, Am. Jour. M. S., ix, 100	Opium, Camphor, Mercury, Complete Ptyalism, Assafœtida.
297	14	Fem'le	Puncture of sole of foot	3d day...	Fatal 5th day.....	W. W. Valk, Am. Jour. M. S., ix, 570	Cathartics, Blisters to Spine.
298	47	Male.	Puncture of sole of foot	....	Fatal 3rd day.....	W. W. Valk, Am. Jour. M. S., ix, 546	Cathartics, Blisters to Spine.
299	60	"	Puncture of sole of foot and ball of great toe by nail	7 days...	Fatal 3rd day.....	W. H. Rankin, Pro. Med. and Surg. Journal, 1847	Ether Inhalation.

OBSERVATIONS OF VARIOUS PHYSICIANS AND SURGEONS—Continued.

No. of Case	Age	SEX.	NATURE OF INJURY.	APPEARANCE OF SYMPTOMS. DAYS.	RESULT AND IN WHAT TIME AFTER DAYS.	AUTHORITY.	TREATMENT AND REMARKS.
300	26	Male.	Injury of back by fall	2d day	Fatal 24 hours	Dr. Baily, Dublin Med. Press, 1847	Ether Inhalation.
301	...	"	Arm shattered by falling stone.	4 days	Fatal	Dr. Broughton, Prov. Medical Journal, 1847	Opinm, Belladonna. Ether Inhalation.
302	...	"	......	......	Recov'ed	M. Pertuseo, Clin. de. Mar., 1847	Ether Inhalation.
303	...	"	Scalp wound	......	Recov'ed	Mr. Hakesworth, Prov. Medical and Surg. Jour., 1847	Ether Inhalation.
304	28	Fem'le	Splinter in thumb of right hand	16th day	Recov'ed 30 days	W. W. Valk, M. D., Am. J. M. S., 1848, 351	Acetate of Lead and Opium, Blister to Spine, Port Wine and Brandy.
305	17	Male.	......	......	Fatal	C. A. Worthington, Prov. Med. and Surg. Jour., 1848	Chloroform Inhalation.
306	...	"	Phlegmonous Erysipelas	6th day	Recov'ed 9 days	Dr. James Parish, Trans. Phil. Co. Phys., ii	Opium. Assafœtida, Inhalation of Ether.
307	...	"	......	......	Fatal	Dr. Hughes, Lon. Med. Gaz., 1848	Tracheotomy.
308	...	"	Dislocation and wound of ankle and amputation	11 days	Fatal 3 days	M. Roux, L. M. Gaz. 1848	Ether and Chloroform Inhalations.
309	24	"	Injury of foot by tight boot		Recov'ed 14 days	S. C. Thornton, N. J. Med. Rep., 1841	Chloroform and Sulphuric Ether Inhalation, Venesection, Calomel, Morphia. Took four-hundred and ten grains of Calomel, which caused free-Salivation; also twenty-five grains of Morphia, twenty-eight ounces of Sulphuric Ether, and eight ounces of Chloroform.
310	27	"	Wound of thumb by saw	5th day	Recov'ed 5 days	E. H. Clarke, Am. J. M. S., 1849, 75	Chloroform Inhalation, Beef Tea and Tonics. Immediate alleviation followed the administration of Chloroform; inhalation was continued uninterruptedly for twenty-five hours. After an interval of forty hours, the inhalation was recommenced and continued for six additional hours. No perceptible ill effect followed the prolonged inhalation of Chloroform. Chloroform was the only agent used in this case.

					34 days..	Dr. T. T. Russell, Am. J. M. S., 1853, 266	Opium. One thousand three hundred grains of Opium and thirty grains of Morphia, produced no beneficial effects; Blisters applied whole length of Spine, Chloroform Inhalations. Recovery referred to Chloroform.
312	28	Fem'le	Wound of the left thumb under the nail by a fork	48 hours	Recov'ed 4 days	S. D. Townsend, Am. J. M. S., 1853, 369	Opium.
313	9	"	Right wrist cut with glass	30 days..	Recov'ed 12 days..	E. W Skues, Edin. Med. Jour., 1858, 361	Indian Hemp, two grains hourly, until Narcotism was produced, Nutritious diet.
314	38	"	Bite of eel on index finger of left hand	21 days..	Recov'ed 24 days..	F. Henkle, Am. J. M. S., 1856, 341	Local applications of Chloroform to Spine, Purgatives, Extract of Cannabis Indica.
315	41	"	Ovariotomy	14 days..	Fatal 7 days	F. Spencer Wells, Am. J. M. S., 1860, 252	Woorara, hyperdermically and epidermically; six grains of the extract in two days.
316	38	"	Ovariotomy	7 days...	Fatal 3 days	F. S. Wells, Am. J. M. S., 1860, 252	Woorara.
317	51	"	Peroneal operation for prolapse of uterus	4 days...	Fatal	F. S. Wells, Am. J. M. S., 1860.	Opium, Ether, Woorara, Chloroform.
318	30	Male.	Wound of left thigh with pitchfork	10 days..	Recov'ed 17 days..	Brit. Med. Jour., 1860	5-10 Minims of Flemming's Tincture of Aconite every four hours; Chlorodyne, Brandy and Beef Tea.
319	22	"	Wound of gluteus muscles by sharp piece of plank	11 days..	Recov'ed 8 days....	Maryland and Virginia Medical Jour., June 1860	Cannabis Indica. In three days seven hundred and eighty grains, in all one thousand four hundred and thirty-seven grains of Squire's Extract of Cannabis Indica administered. Tetanus relieved, but semi-delirium induced.
320	42	"	Wound of foot with large nail.	5th day..	Recov'ed 9 days ...	Maryland and Virginia M. J., June, 1860	Opium 80 grains, and Camphor 160 grains, every 24 hours. Whole quantity Opium 700 grs., of Camphor 1400.
321	...	"	Severe bruises and exposure to cold	13th day	Recov'ed 10 days..	Dr. R. Lebby, Charleston Med. Jour. and Rev., 1850, 297	Mercury, Salivation, Leeches, Morphia.
322	...	"	Splinter of wood in thumb of left hand	12th day	Fatal 3rd day....	Dr. R. Lebby, Char. Med. Jour. and Rev., 1850, 297	Mercury. Blister over spine, Morphia.
323	...	Fem'le	Extraction of tooth	2d day...	Recov'ed 7 days.	Dr. R. Lebby, Char. Med. Jour., 1850, 100	Mercury, Salivation, Morphia.
324	...	Male.	Wound of chin	5th day..	Recov'ed 6 days	Dr. R. Lebby, Char. Med. Jour. and Rev., 1850, 302	Mercury, Calomel, Salivation, Morphia.
325	36	"	Palm of hand pierced by prong of pitchfork	24 hours	Relieved	J. L. Ord, Am. J. M. S., 1861, 603	Chloroform and Tincture of Opium, internally; equal parts of Chloroform and Tincture of Opium, teaspoonful every hour; same mixture applied to the arm.
326	...	"	....	....	Fatal	Maryland and Virginia M. J.. 1861	Inoculation with Corroval.
327	27	"	Abrasion of skin of fingers	few days	Fatal	Guy's Hospital Reports, 1844	Cannabis Indica.
328	...	Fem'le	Extraction of tooth		Recov'ed	Phil. Med. Ex., April, 1846	Morphia and application of Ice to Spine.

OBSERVATIONS OF VARIOUS PHYSICIANS AND SURGEONS—Continued.

No. of Case	Age	SEX.	NATURE OF INJURY.	APPEARANCE OF SYMPTOMS. DAYS.	RESULT AND IN WHAT TIME AFTER. DAYS.	AUTHORITY	TREATMENT AND REMARKS.
329	...	Male	Puncture of foot by rusty nail	....	Recov'ed 20 days	Dr. Bishop, N. Y. J. M., Sept., 1847	Quinine. Wound incised. Actual Cautery, Purgatives, 15 grs. of Quinine and ¾ grs. of Morphia, at intervals.
330	9	"	Incised wound of index finger	13th day	Recov'ed 6 days	J. Hopgood, Med. Times, 1848	Ether Inhalation.
331	45	"	Cut in neck and fracture of Clavicle	15th day	Recov'ed 7 days	G. Sloman, Prov. M. and S. J., Sept. 5, 1849	Chloroform by Inhalation, Calomel, Morphia.
332	45	"	Wound of leg by axe	5 days	Recov'ed 5 days	M. Thoriseau, Union Medicale, 1851	Chloroform frictions. Acidulated vapor baths.
333	...	"	Wound of thigh with needle	3d day	Recove'd 11 days	Mr. Eddome, Med. Gaz., May 2, 1851	Local application of Morphia to wound. Morphia to Blistered Surface.
334	26	"	Injury of toe by nail	5 days	Recov'ed 18 days	Dr. Dusch. Schm. Jah., 1858	Chloroform Inhalation. During the first three days, Morphia, Venesections, Cupping, Tobacco enemata and Mercurials, were tried assiduously without any good results; on the contrary, the spasms had become more violent and frequent; the pulse had risen to 112, the agony and difficulty of breathing had become almost intolerable. Chloroform was now tried, and with instant relief—the spasm relaxing, the breathing becoming free, the pulse falling to 60. The Chloroform was kept up, as the symptoms required: not less than 64½ ozs. being consumed in 14 days.
335	18	"	Laceration of fore arm by cogs of wheel	17 days	Recov'ed 11 days	L. Woodworth, N. Y. Jour. Med. May, 1853	Chloroform and Ether Inhalations, Morphia.
336	...	"	Amputation of arm for gunshot wound	19 days	Recov'ed 14 days	T. T. Lowes, Med. Times and Gaz., May 4th, 1853	Chloroform Inhalations, and embrocations of spine, throat and chest, with Chloroform. Extract of Belladonna and Soap Liniment.
337	27	"	Contused wound of knee	17 days	Recov'ed	G. Garnham, Lancet, Aug. 18, 1855	Calomel, Opium. Chloroform locally. Blisters over spine, and seat of Injury. Frictions with Tincture of Aconite and Soap Liniment.
338	54	Fem'le	Incised wound of finger	21 days	Recov'ed 14 days	W. A. McDowell, N. O. Med. and Surg. Jour., 1845, p. 574	Free incision of finger. Cantharides applied to wound. Calomel and Opium.

339	13	Male.	Inside of right foot cut with axe	27 days..	Recov'ed 8 days....	W. A. McDowell, N. O. Med. and Surg. Jour., 1845	Incision of Cicatrix; wound sprinkled with Corrosive Sublimate and red precipitate.
340	22	Fem'le	Wound of foot with splinter...	6 days...	Fatal 4th day.....	W. A. McDowell, N. O. Med. and Surg. Jour., June, 1845........	Blood-letting, Stimulants, Anti-spasmodic. Free incisions of wound.
341	30	"	Wound of foot with splinter...	14 days..	Recov'ed 24 hours	W. A. McDowell, N. O. Med. and Surg. Jour., 1845	Actual Cautery, Blood-letting, warm poultices.
342	...	Male.	Wound of ball of great toe with rusty nail	2 hours..	Recov'ed 24 hours	W. A. McDowell, N. O. Med. and Surg. Jour., 1845	Blood-letting, Opium. Actual Cautery. Attacked with spasms of violent character, jaws firmly clinched. Actual Cautery produced efficient and rapid relief. The patient described the sensations of the Actual Cautery as "*delightful.*"
343	...	Fem'le	Wound of foot by splinter	....	Fatal 24 hours.....	W. A. McDowell, N. O. Med. and Surg. Jour., 1845	Free incisions of Cicatrix, extraction of Splinter. Application of Corrosive Sublimate and red precipitate to the wound.
344	20	Male	Incision of ankle joint	4 days...	Fatal 48 hours.....	New Orleans Medical and Surg. Journal, 1845	Amputation of Leg.
345	19	Fem'le	Punctured wound of foot and toe with glass	120 days	Recov'ed	E. F. Wilson, West Journal of Med., 1841	Incision of toe and extraction of particle of glass, Antimony, Opium and Calomel.
346	29	Male.	Punctured wound of foot	60 days..	Fatal 48 days..	W. G. G. Wilson, N. O. Med. and Surg. Journal, 1845, 156.	Cannabis Indica. The patient appeared to be entirely relieved by the Indian Hemp, when he was attacked by Measles, 36 days after the appearance of the Tetanus. The rash receded, the pulse became accelerated and violent tetanic spasms supervened which were not relieved by Brandy, Quinine, Indian Hemp and Morphia.
347	25	"	Large nail driven through foot.	8th day .	Recov'ed 15 days..	A. Hester, N. O. Medical and Surg. Journal, 1846, p. 306...	Quinine in large doses; 60 grains of Quinine were given on the 3d day, 70 grains on the 4th, and so on for four or five days. The effect was the reduction of the pulse, from 100 to 80, the excitation of free perspiration, diminution of the rigidity of the muscles, and of the frequency and violence of the clonic spasms.
348	...	Fem'le	Vaccination	....	Recov'ed 14 days..	J. B. Cottman, N. O. Med. and Surg. Journal, 1855, 783......	Opium. In two weeks, patient took 2 ozs. Opium and thirty-six fluidounces of Laudanum in enemas. The vaccine scar was Cauterized.
349	14	Male.	Wound of face	14 days..	Recov'ed 14 days..	E. A. Pye, N. O. Med. and Surg. Journal, 1853, 436	Quinine, 30 to 40 grains at a dose; in two weeks the boy took 2 ozs. Quinine.
350	35	Fem'le	Flesh wound of head	5 days...	Recov'ed 24 days..	S. Martin, L. U. Medicale, May, 1852	Cyanuret of Potassium and Chloroform. Recovery attributed to the Chloroform administered internally, 20 to 30 drops.

OBSERVATIONS OF VARIOUS PHYSICIANS AND SURGEONS—Continued.

No. of Case	Age	SEX.	NATURE OF INJURY.	APPEARANCE OF SYMPTOMS. DAYS.	RESULT AND IN WHAT TIME AFTER, DAYS.	AUTHORITY.	TREATMENT AND REMARKS.
351	15	Male.	First and second fingers cut with a saw	6 days	Recov'ed 8 days	D. H. Fugate, N. O. J. Med. and Surg., 1853, 193	Quinine, Morphine and Brandy. Blister to Spine and end of fingers. A batch of Carded Cotton, was saturated with Oil of Turpentine, spread over the Spine, and set on fire, thus blistering the whole length of the back. In 12 hours the patient took 12 grains of Morphia, one pint of Brandy and 30 grains of Quinine.
352	50	Fem'le	Hand burned with fire	....	Recov'ed 17 days	D. H. Fugate, N. O. J. Med. and Surg., 1853, 193	Morphine, Whiskey, Beef Tea.
353	...	"	Burn, (clothes caught on fire)	....	Recov'ed 7 days	D. H. Fugate, N. O. J. Med. and Surg., 1853	Chloroform Inhalations. Quinine, Brandy and Morphine.
354	...	Male.	Frost bite of toes	....	Recov'ed 8 days	D. H. Fugate, N. O. J. M. S., 1853	Chloroform Inhalations. Chloroform and Camphor by Enema, Brandy and Morphine.
355	19	Fem'le	Administration of Quinine by hypodermic injection	11 days	Fatal 30 hours	E. P. Sole, N. O. J. M. and S., 1871, 319	Chloroform by Inhalation. Quinine, Morphine and Atropine.
356	24	"	Wound of heel of foot by shoe nail	13 days	Recov'ed 7 days	G. E. Foster, N. O. J. Med. and S., 1870, 613	Exsection of Internal Plantar Nerve.
357	...	Male.	Great toe of right foot crushed	10 days	Recov'ed 18 days	F. O. Meux, N. O. M. and S. J.	Chloroform by Inhalation and Internally; Quinine 30 grains, morning and evening; Recovery attributed to Chloroform, internally.
358	14	"	Wound of perineum by stick	17 days	Recov'ed	Trans. Am. Med. Ass., 1850	Chloroform by Inhalation.
359	29	"	Wound of foot by adze	42 days	Recov'ed 10 days	Trans. Am. Med. Ass., 1850	Chloroform by Inhalation, and local application.
360	25	"	Wound of posterior surface of left foot by nail	7th day	Fatal 4th day	Prof. Paul F. Eve, So. M. and S. J., 1845, p. 625	Cannabis Indica, Indian Hemp.
361	7	Fem'le	Lacerated wound, middle finger of right hand	....	Recov'ed	James Miller, So. Med. and S. J., 1845, p. 650	Amputation of Finger, Cannabis Indica.
362	7	Male.	Wound of knee by thorn	10 days	Recov'ed 10 days	J. W. Fell, So. Med. and Surg. Journal, 1847, 33	Strychnia [illegible] of a grain, every two hours.
363	25	Fem'le	Removal of toe nail	Few days	Recov'ed 17 days	J. W. Fell, So. Med. and Surg. Journal, [illegible]	Strychnine.

364	29	Fem'le	Wound of palm of hand by needle	10 days	Recov'ed 7 days	J. W. Fell, So. Med. and Surg. Journal, 1847	Strychnine.
365	16	"	Wound of right thumb with carpet tack		Recov'ed 8 days	So. Med. and Surg. Jour., 1847.	Venesection, Wine, Strychnine.
366	35	"	Bruise of right elbow		Recov'ed	So. Med. and Surg. Jour., 1847.	Venesection, Opium, Strychnine.
367	14	"	Wound of sole of foot by bone.	28 days	Recov'ed	C. Botsford, So. Med. and Surg. Journal, 1847, 22	Incision of Cicatrix, Venesection, Opium, Strychnine, Purgatives.
368	...	"	Excision of cutis on joint of thumb	8th day	Recov'ed	E. Vanderpool, So. Med. and Surg. Journal, 1847	Strychnine $\frac{1}{10}$ of a grain, every two hours.
369	...	"	Punctured wound sole of foot by nail	6th day	Recov'ed 18 days	P. M. Kollock, So. Medical and Surg. Journal, 1847, 597	Tobacco Poultices and Enemas; Blisters to Calves of Legs; Strychnine $\frac{1}{16}$ grain, every two hours.
370	24	Male.	Wound of ball of right thumb with scythe	9th day	Recov'ed 36 hours	M. Sweat, So. Med. and Surg. Journal, 1851, 293	Division of Injured Nerve; Spasms ceased immediately.
371	20	"	Joint of right thumb shot off by musket	7th day	Recov'ed 48 hours	M. Sweat, So. Med. and Surg. Journal, 1851, 293	Division of Injured Nerve.
372	20	Fem'le	Branch of ulnar nerve at right wrist punctured by needle	31 days	Recov'ed 2d day	M. Sweat, So. Med. and Surg. Journal, 1851, p. 293	Division of Ulnar Nerve, and section of one inch, just above the groove on the inner Condyle of the humerus.
373	35	"	Ligature of hæmorrhoids	12 days	Fatal 2d day	Dr. James Bolton, So. Med. and Surg. Jour., 1852, 177	Morphine, Quinine. Chloroform by Inhalation.
374	28	Male.	Frost bite, loss of second and third toes	22 days	Recov'ed 13 days	Dr. W. W. Haris, So. Med. and Surg. Journal, 1852, p. 458	Calomel, Indian Hemp, Quinine, Dover's Powders, Brandy.
375	18	"	Injury of great toe of left foot.	5 days	Recov'ed 14 days	Dr. J. C. Bellingsea, So. Med. and Surg. Jour., 1853, p. 454.	Morphine, Quinine; $\frac{1}{4}$ grain Morphine, 15 grs. Quinine, every two hours.
376	16	"	Wound of ball of right foot by splinter	12 days	Recov'ed 7 days	Dr. B. D. Carpenter, So. Med. and Surg. Jour., 1854, p. 172.	Cathartics and Opium; Ice to head and whole length of Spine; recovery attributable to Ice to Spine.
377	21	"	Wound of hollow of foot by rusty nail	5 days	Recov'ed 9 days	Dr. B. D. Carpenter, So. Med. and Surg. Jour., 1854, p. 172.	Purgatives, Dover's Powders. Ice to head and Spine.
378	30	"	Large caustic issue with potassa	2d day	Fatal 9th day	Dr. Kirkpatrick, So. Med. and Surg. Jour., 1855, 29	Chloroform by Inhalation, and locally.
379	...	"	Lacerated wound of thumb and fingers	15 days	Recov'ed	Dr. Kirkpatrick, So. Med. and Surg. Journal, 1855, 39	Cannabis Indica, Belladonna and Mercurial frictions. Chloroform by Inhalation and locally.
380	...	Fem'le	Wound of sole of foot by nail.	7th day	Recov'ed 14 days	Dr. C. Stilwell, So. Med. and Surg. Journal, 1856, 97	Opium, Antimony, Oil of Turpentine. Turpentine and Laudanum applied to Spine.
381	35	Male.	Injury of nail of thumb	7th day	Fatal 3rd day	Dr. C. Stilwell, So Med. and Surg. Journal, 1856, 97	Dover's Powders, Quinine, Turpentine. Turpentine and Laudanum applied to Spine.
382	...	"	Wound of hand by splinter	14th day	Fatal 20 hours	H. R. Casey, So. Med. and Surg. Journal, 1856, 730	Chloroform by Inhalation, Opium, Assafœtida, Blister down Spine. Turpentine, Warm Bath of Peach leaves.
383	9	Fem'le	Lacerated wound of thigh	13 days	Recov'ed 38 days	M. Bosquet, So. Med and Surg. Journal, 1857, 77	Chloroform internally and by Inhalation. Tincture of Opium.

OBSERVATIONS OF VARIOUS PHYSICIANS AND SURGEONS—Continued.

No. of Case	Age	SEX.	NATURE OF INJURY.	APPEARANCE OF SYMPTOMS. DAYS.	RESULT AND IN WHAT TIME AFTER. DAYS.	AUTHORITY.	TREATMENT AND REMARKS.
384	40	Male.	Laceration of right hand necessitating amputation of two fingers	25th day	Fatal 16th day	Dr. H. F. Campbell, So. Med. and Surg. Jour., 1857, p. 81	Chloroform internally. Morphia, Quinine, Camphor, Carb. of Iron.
385	45	"	Wound of palm of hand by spiculae of bone	21 days	Fatal 4th day	Dr. E. Mason, Am. Med. Times, 1860, p. 150	Scar upon hand freely incised and poulticed; Spine rubbed with a solution of Veratria, 3 grains to fluidounce of Alcohol. Brandy and Tincture of Assafœtida by injection and by the mouth, Chloroform by Inhalation. The Chloroform relieved the Spasms temporarily, and the patient was able to swallow Nutriment and Stimulants; died at the close of a severe Spasm, apparently from exhaustion, having slept none, except when under the influence of Chloroform.
386	16	"	Lacerated wound of fore arm by circular saw	10 days	Fatal 3d day	Dr. H. Pinckney, Am. Medical Times, 1861, p. 61	Cannabis Indica, Chloroform by Inhalation. Brandy, Beef Tea.
387	27	"	Opening of abscess of thigh	Sev. d'ys	Recov'ed sev. w'ks	Dr. W. T. Coles, Am. Medical Times, 1861, p. 61	Ten drops of Tincture of Opium, and fluidounce of Brandy every hour.
388	24	"	Gunshot wound of left arm	21 days	Recov'ed	Dr. G. Williams, Am. Medical Times, 1861, p. 75	Chloroform and Extract of Belladonna internally; 40 minims of Chloroform and 1½ grains of Extract of Belladonna were given every two hours. Opiates in large quantities had produced no beneficial effects; Dr. Williams thought that the patient could not survive an hour, on the morning that he resolved to give Chloroform internally. Recovery attributed to the Chloroform.
389	10½	"	Middle finger of right hand mashed by door	10 days	Recov'ed 17 days	G. Smith, Am. Medical Times, 1861, p. 75	Tincture of Aconite, Flemings, two drops every hour; one ounce and twelve minims were given in 17 days. The specific effects of Aconite as detailed by authors, were observed in this case. Dr. Smith observed nothing to warrant the idea, that the primary action of Aconite is stimulant; but the Sedative action was apparent from the first cessation of the Tetanic

							Spasms; though this action did not last so long as the specific effects upon the system.
390	22	Male.	Compound dislocation of thumb	5th day	Fatal 32 hours	St. John Roosa, Am. Medical Times, iii, 1861, 307	Assafœtida Injections, Milk Punch, Beef Tea.
391	14	"	Crushed toes, great and two adjoining toes amputated	10th day	Fatal 4th day	St. John Roosa, Am. Medical Times, iii, 1861, 307	Assafœtida Injections.
392	45	"	Compound fracture of bones of leg	12th day	Fatal 26 hours	St. John Roosa, Am. Medical Times, iii, 1861, 307	Assafœtida and Morphia.
393	50	"	Gunshot wound of chest, three inches below axilla	....	Fatal	Ass. Surg. Uhler, U. S. A., Am. Med. Times, vol. vi, p. 222	Chloroform by Inhalation.
394	14	"	Fracture of arm. Gangrene, Amputation at upper 3d	2d day	Fatal 24 hours	Ass. Surg. Uhler, Am. Medical Times, vi, 222	Sub-Cutaneous Injection of Solution of Woorara, into areolar tissue of thigh. The pulse which was very rapid immediately began to fall, and in the course of ten minutes, came down to 45 beats per minute; during ten minutes more, it continued to fall more slowly, when at length it entirely ceased, 20 minutes after the introduction of the Woorara.
395	...	"	Burn of side of neck and arm	....	Recov'ed	Dr. C. C. Cox, Am. Med. Times, vi	Chloroform by Inhalation. Opium, Cold Baths.
396	25	"	Gunshot wound of shoulder	18th day	Recov'ed 4 days	Surg. L. Quick, Am. Medical Times, vi.	Chloroform internally. Acetate of Morphia; wound dressed with Solution of Morphia.
397	...	"	Lacerated wound of foot	10 days	Fatal 48 hours	Surg. L. Quick, Am. Medical Times, vi	Acetate of Morphia.
398	27	"	Wound of foot by rusty nail	....	Recov'ed 48 days	E. Watson, Pract. 1870, 207	Calabar Bean; two grains of the Alcoholic Extract at a dose; and at varying periods; 1026 grains given in 46 days.
399	29	"	Right foot crushed by wheel, necessitating amputation	18 days	Recov'ed 32 days	W. Harning, London, Lancet, 1869, p. 834	Sub-Cutaneous Injection of Extract of Calabar Bean. In 30 days, about 30 drachms of the Extract of Calabar Bean were injected, generally in quantities of ½ grain. The antagonistic effect of the Calabar Bean upon the well marked Trismus and Opisthotonos was immediate and complete.
400	52	"	Compound comminuted fracture, third finger, right hand.	11th day	Recov'ed 20 days	M. Foster, Lancet, 1870, p. 532.	Nitrite of Amyle by Inhalation, 5 drops on handkerchief; beneficial effects marked and immediate.
401	...	"	Compound comminuted fracture of extremity of right radius	8th day	Recov'ed 30 days	M. Leibrich, Lancet, 1870, 560	Hydrate of Chloral. Effects prompt, decisive and beneficial.
402	16	Fem'le	Compound fracture of fore finger of left hand	12th day	Recov'ed 20 days	A. Boutflower, Manchester Med. and Surg. Report, 1870, 52	Extract of Calabar Bean, by mouth and by injection. Amputation, of finger; the Extract of Calabar Bean was given every 2 hours, alternately by the skin and mouth, so that in every 4 hours 1½ grs. were administered, viz: 1 grain by the mouth and ½ a grain by the skin. During the attack the total amount of the extract administered was 90¾ grains, in 10 days.

OBSERVATIONS OF VARIOUS PHYSICIANS AND SURGEONS—Continued.

No. of Case	Age	SEX.	NATURE OF INJURY.	APPEARANCE OF SYMPTOMS. DAYS.	RESULT AND IN WHAT TIME AFTER DAYS.	AUTHORITY.	TREATMENT AND REMARKS.
403	34	Male.	Wound of left thumb at base of nail with thorn	14 days	Recov'ed 21 days	A. Ballantyne, Lancet, 1870, 545	Hydrate of Chloral; 3100 grains of Chloral used in this case.
404	...	"	Compound fracture of leg	28 days	Fatal 21 hours	G. A. Turner, Lancet, 1870, 508.	Calabar Bean.
405	26	"	Injury to ulcer on leg	7 days	Recov'ed 10 days	Mr. Birkett, Lancet, 1870, 434	Chloral Hydrate.
406	23	"	Wound of face	19 days	Fatal 11 days	Mr. Eager, Lancet, 1871, 159	Chloral Hydrate.
407	23	"	Injury of face and eyes, caused by explosion of gun powder.	7 days	Fatal 11 days	Mr. Tyrrell, Lancet, 1871, 265	Chloral Hydrate.
408	17	"	Compound fracture of right great toe	10 days	Recov'ed 8 days	J. S. Knox, Am. Jour. Med. Sci., 1871, 428	Chloral Hydrate; 30 grains every 4 hours.
409	12	"	Wound, upper portion right leg	13th day	Recov'ed 21 days	Dr. Thomas, Rich. Louisville Med. Jour., November, 1872.	Chloral Hydrate; 1200 grains during attack, Milk Punch, Beef Tea.
410	...	"	Compound comminuted fracture, fore and middle fingers.	8 days	Recov'ed 2 days	J. A. Beck, St. Louis Med. Jour.	Chloral Hydrate; 60 grains every half hour; 420 grains in 3 hours.
411	...	"	Injury of hand		Recov'ed	Richmond, Louisville Medical Journal, 1872	Hydrate of Chloral and continuous Electric Current.
412	18	"			Recov'ed	E. R. Denton, Brit. Med. Jour., 1870	Hydrate of Chloral, Bromide of Potassium, Belladonna.
413	...				Recov'ed	J. W. Ogle, Lancet, 1870	Hydrate of Chloral, Ice to Spine, Bromide of Potassium, Belladonna.
414	...				Recov'ed	J. G. Duncan, Am. Prac., 1870.	Hydrate of Chloral, Calabar Bean.
415	...				Fatal	P. Peter, Am. Prac., 1870	Hydrate of Chloral, Calabar Bean.
416	...				Recov'ed	A. Ferguson, Ed. Med. Journal.	Bromide of Potassium 2,700 grains, Hydrate of Chloral 3,600 grains.
417	...				Recov'ed	Dr. Lavo, Ann. Un. Med., Feb., 1872	Hydrate of Chloral 240 grammes during case, also 25 Cold Baths.
418	...				Recov'ed	Dr. Lavo	Hydrate of Chloral 147 grammes, 15 Cold Baths.
419	...				Recov'ed	Dr. Lavo	Hydrate of Chloral 140 grammes, 11 Cold Baths.

			phalanx............................	21 days..	Fatal 7th day.....	Paul F. Eve, M. D., Remarkable Cases in Surgery, p. 674......	
425	...	Fem'le	Stabbed in fore arm and nose wounded	24 hours	Recov'ed 7 days...	F. H. Hamilton, Mil. Surg., 595.	Dover's Powders, Venesection.
426	60	"	Thumb pierced with needle.....	60 days..	Recov'ed 5 months	F. H. Hamilton, Mil. Surg., 596.	Tonics.
427	45	Male.	Lacerated wound of hand........	16 days..	Recov'ed 35 days..	F. H. Hamilton, Mil. Surg., 596.	Free use of Stimulants and Opiates; patient experienced great relief from injection per rectum of 2 grains of Acetate of Morphia, every 4 hours; Nutritious Diet.
428	35	"	Fracture of arm and lacerated wound of thigh.................	12th day	Fatal 22d day..	F. H. Hamilton, Mil. Surg., 596.	Stimulants and Opiates.
429	10	"	Fracture of both bones, right arm................................	5th day..	Fatal 24 hours.....	F. H. Hamilton, Mil. Surg., 597.	Chloroform Inhalations, Morphine.
430	13	"	Fracture of right leg.............	8th day..	Fatal 10th day	F. H. Hamilton, Mil. Surg., 597.	Assafœtida, and McMunn's Elix. of Opium.
431	41	"	Injury of finger.....................	13 days..	Fatal 4th day.....	F. H. Hamilton, Mil. Surg., 598.	Cannabis Indica.
432	37	"	Gunshot wound of left wrist...	36 hours	Fatal 4th day.....	F. H. Hamilton, Mil. Surg., 598.	Chloroform by Inhalation every half hour. Morphia.
433	30	"	Laceration of right buttock by fragment of shell, and lesion of sciatic nerve.................	17 days..	Recov'ed 35 days..	Med. and Surg. Hist. of Brit. Army in War against Russia, 1854, 5, 6, vol. ii, p. 285, 279.	Calomel and Opium, Turpentine, Enema.
434	...	"	Gunshot wound of left arm; lesion of ulnar nerve..........	7th day..	Fatal 2 days....	Med. Surg. Hist. of Brit. Army. vol. ii..............................	Calomel, Opium, Chloroform.
435	...	"	Contusion of face, destruction of eye, and lesion of optic nerve................................	4th day..	Fatal 2 days...	Med. Surg. Hist. of Brit. Army, vol. ii......	Spine Blistered and sprinkled with Morphine; Calomel in small doses, Chloroform.
436	...	"	Bullet wound of shoulder, injury of axillary plexus.........	same day	Fatal......	Med. Surg. Hist. of Brit. Army, 1854–56, ii........................	Rapidly fatal.
437	22	"	Compound comminuted fracture of left clavicle cervical nerve injured.....................	12th day	Fatal 15 hours.....	Med. Surg. Hist. of Brit. Army, 1854–56, ii........................	Calomel and Opium, to Salivation.

No. of Case	Age	SEX.	NATURE OF INJURY.	APPEARANCE OF SYMPTOMS. DAYS.	RESULT AND IN WHAT TIME AFTER. DAYS.	AUTHORITY.	TREATMENT AND REMARKS.
438	24	Male.	Shell wound of foot, secondary hemorrhage, amputation......	11th day	Fatal 4 days...	Med. Surg. Hist. of Brit. Army, 1854–56, "	
439	...	"	Gunshot wound of left thigh, lesion of sciatic nerve.........	7th day..	Fatal 3 days...	Med. Surg. Hist. of Brit. Army, 1854–56, "	Calomel, Opium, Chloroform.
440	...	"	Primary amputation of leg......	....	Fatal......	Med. Surg. Hist. of Brit. Army, 1854–56	Calomel, Opium, Chloroform.
441	32	"	Right leg carried away by shell. Amputated.........................	5th day..	Fatal 4 days...	Med. Surg. Hist. of Brit. Army, 1854–56	In the Crimean cases, lesion of the nerve was the known cause in six cases; amputation appears to have been so in five, in all of which lesion of the nerve must have happened; compound fracture in three, in one of which from the simple fact of the tetanic disease not having been set up till the 19th day, and then proving fatal in four, it seems probable, that lesion of the nerve had taken place from movements of the injured bone, at a period subsequent to the original injury. Uncomplicated flesh wounds, without known lesion of nerve appears to have been the cause in seven instances. The result in the Crimea, strengthened the belief, that Tetanus is generally, if not always consequent upon irritation applied to nervous filaments.
442	...	"	Compound fracture of both bones of fore arm; sphacelus; amputation fourth day.........	8th day..	Fatal 5 days...	Med. Surg. Hist. of Brit. Army.	
443	...	"	Compound fracture of bones of fore arm. Primary amputation	10 days..	Fatal 4 days...	Med. Surg. Hist. of Brit. Army.	
444	...	"	Compound fracture of scapula by bullet..........................	....	Fatal......	Med. Surg. Hist. of Brit. Army.	
445	...	"	Compound fracture of ischium, and injury of fibula by grape shot................................	....	Fatal......	Med. Surg. Hist. of Brit. Army.	
446	38	"	Compound fracture of tibia......	19th day	Fatal 4 days...	Med. Surg. Hist. of Brit. Army, 1854–56..........................	
447	27	"	Flesh wound, nape of neck......	4th day..	Fatal 2 days...	Med. Surg. Hist. of Brit. Army.	Free incisions in vicinity of the wounds, Drastic Purgatives. Blisters along the Spine, Morphia and Chloroform.
448	...	"	Flesh wound of perineum........	....	Fatal 2½ days..	Med. Surg. Hist. of Brit. Army, 1854–56..........................	
449	...	"	Flesh wound of lower extremity	....	Fatal......	Med. Surg. Hist. of Brit. Army.	
450	[illegible]	"	Flesh wound of leg	....	Fatal......	Med. Surg. Hist. of Brit. Army	
451	[illegible]	"	Flesh wound of hip and buttock	[illegible]	Fatal [illegible]	[illegible]	[illegible]

452	19	Male.	Flesh wound of thigh; ball extracted	12th day	Fatal 5th day	Med. Surg. Hist. of Brit. Army.	Opium. Chloroform by Inhalation.
453	25	"	Frost bite	21st day	Recov'd 30 days	Med. Surg. Hist. of Brit. Army.	Opium, Chloroform, Sulphuric Ether, Purgatives.
454	...	"	Slight abrasion sole of foot	...	Fatal	Med. Surg. Hist. of Brit. Army, 1854–56, ii	
455	25	"	Gunshot wound of ankle	...	Recov'd 14 days	Surgeons Cabell and Davis, C. S. M. Hospital, Charlottesville, Virginia, 1863	Blister whole length of Spine. Morphine.
456	25	"	Gunshot wound of ileum and abdominal cavity	...	Recov'd	Surgeons Cabell and Davis, C. S. M. Hospital, Charlottesville, 1863	Opium.
457	28	"	Gunshot wound of left foot and thigh	13 days	Fatal 6th day	Surgeons Cabell and Davis, C. S. M. Hospital, Charlottesville, 1863	Chloroform and Tincture of Opium internally.
458	23	"	Compound fracture of femur	10 days	Fatal 3d day	Drs. Cabell and Davis, C. S. M. Hospital, 1863	
459	35	"	Gunshot wound of right arm fracture of humerus	18th day	Fatal 8 days	Drs. Cabell and Davis, C. S. M. Hospital, 1863	Chloroform by Inhalation.
460	23	"	Gunshot wound of scapula and pectoralis major	...	Fatal	Surgeons Cabell and Davis, C. S. M. Hospital	
461	25	"	Gunshot wound of shoulder. Fracture of neck of humerus wound of chest and left hand.	19th day	Recov'd 14 days	Surgeons Cabell and Davis, Confederate States Military Hospital, Charlottesville, Va., 1863	Large doses of Opium and Alcoholic Stimulants; warm water applied by blankets. Of the seven cases of Traumatic Tetanus, entered upon the Hospital Records of the Charlottesville General Hospital, during the Civil War 1861–1865, 4 terminated fatally, and the three which recovered were very mild in their inception and progress. No special mode of treatment was found to avail in the seven cases. Chloroform was used, both internally and by inhalation, but without decided effects in arresting the disease. The proportion of cases of Tetanus to the whole number of wounded, treated at this and other Confederate Hospitals, during the American Civil War was small. The experience of Confederate Surgeons, was to the effect, that whenever Tetanus puts on the acute form, no curative proceeding will avail. While in the milder and more tardy form, the most varied remedies have been followed by recovery.

OBSERVATIONS OF VARIOUS PHYSICIANS AND SURGEONS—Continued.

No. of Case	Age	SEX.	NATURE OF INJURY.	APPEARANCE OF SYMPTOMS. DAYS.	RESULT AND IN WHAT TIME AFTER DAYS.	AUTHORITY.	TREATMENT AND REMARKS.
462	...	Male.	Leg wounded by cannon ball. Thigh amputated at lower third	9th day	Recov'ed 20 days	Surg. W. A. Davis, C. S. Med. and Surg. Jour., June, 1864, p. 8	Quinine, Morphine, Milk Punch.
463	...	"	Flesh wound	11th day	Fatal a few hrs.	Surgeon S. E. Habersham, C. S. Med. and Surg Journal, 1864, p. 45	
564	...	"	Compound fracture of fibula	12 days	Fatal 24 hours	Surgeon S. E. Habersham, C. S. Med. and Surg. Journal, Jan., 1864, p. 45	During the American Civil War, 1861–1865, an interesting discussion was carried on in Richmond, Virginia, by the Association of Confederate Army and Navy Surgeons, as to the difference between Tetanus and Tetanic Spasms. See Confederate States Medical and Surgical Journal, March, 1864 to June, 1864. On the one hand, Dr. Michel expressed the belief that true Tetanus nearly always commenced with Trismus, and not in local contractions of the limb, which are comparatively mild, and capable of control by treatment. True Traumatic Tetanus, on the contrary, is one of the most fatal of all Diseases. Muscular irritability discloses itself by two very distinct phenomena, described as *clonic and tonic contractions*; in Tetanus the contractions are of the *tonic* variety, slow and long continued decurtations of the muscular fibre, with gradual relaxations; but in the jerkings and twitchings of groups of muscular fibres referred to, the muscular contractions were rapid and frequent and more of the clonic order. On the other hand Dr. H. F. Campbell, regarded tetanic spasms as identical in nature and pathology with Tetanus; the former being applied to tetanic phenomena, affecting a very restricted portion of the muscular system, the excito-motory arch being
465	...	"	Gunshot wound of elbow	11 days	Fatal 4th day	Surgeon Carsyle Terry, C. S. Med. and Surg. Journal, Jan., 1864, p. 76	
466	35	"	Compound fracture of left leg	3d day	Fatal 4th day	Surgeon M. H. Houston, C. S. Med. and Surg. Jour., Jan., 1865, 62	
467	16	Fem'le	Wound of bottom of foot by nail	3d day	Fatal 7th day	M. H. Houston, C. S. Med. and Surg. Jour., Jan., 1865, 62	
468	...	Male.	Compound comminuted fracture of right leg	28 days	Fatal 3rd day	M. H. Houston, C. S. Med. and Surg. Jour., Jan., 1865, 63	

							discrimination in this particular, the results of treatment would appear to be strangely at variance with what is known regarding the mortality in this disease.
469	38	Fem'le	Severe burn of lower extremities	7th day..	Fatal 3rd day.....	T. R. Wood, M. D., So. Med. and Surg. Jour., May, 1858, 339..	Twenty fluidounces of Brandy, and one pint of Madeira Wine in 24 hours; ½ grain of Morphia every 2 hours.
470	...	Male.	Wound of great toe, near joint by nail	5 days...	Recov'ed	W. W. Anderson, So. Med. and Surg. Jour., 1858, p. 340......	Amputation of toe. The usual remedies had been employed without avail; cure referred to Amputation.
471	33	"	Scalp wound	21 days..	Recov'ed 28 days..	Mr. Ashdown, Brit. Med. Jour., March 21st, 1868..........	Calabar Bean; ⅓ grain extract every hour. On second day bled to 1 pint; Brandy and Wine.
472	29	"	Flesh wound at battle of Chancellorsville	6 days...	Recov'ed 5 days...	Lancet, 1864, 267..................	Opium and Brandy, 1 grain of Morphia and two drachms Tincture of Opium, in half pint of Brandy.
473	37	"	Injury by saw over right frontal eminence	8th day..	Recov'ed 21 days..	Dr. Grant, Med. Times and Gaz., 1865, ii, 495......................	Indian Hemp, Ice to Spine, Acupuncturation; cure attributed to the latter measure; 3 needles were inserted into the muscles of the neck on each side, within one inch of Spinous process.
474	...	"	Amputation of arm	2d day...	Fatal......	W. A. Hammond, Diseases of Nervous System, 542.........	Cannabis Indica, Morphia, Injections of Coroval,
475	...	"	Wound of foot by nail	14 days..	Recov'ed 14 days..	W. A. Hammond, Diseases of Nervous System, 542..........	Cannabis Indica and Ice to the Spine.
476	...	"	Ice prick thrust through hand..	9th day..	Recov'ed 16 days..	W. A. Hammond, Diseases of Nervous System, 542..........	Cannabis Indica, Ice to Spine.
477	...	"	Splinter in thumb	12 days..	Recov'ed 25 days..	W. A. Hammond, Diseases of Nervous System.................	Cannabis Indica, Ice to Spine.
478	40	Fem'le	Wound of finger with splinter..	30th day	Recov'ed 16 days..	Dr. Coryllos, A. A. M. and S. J., 1874, 86...........................	Hydrate of Chloral, one ounce daily.
479	40	Male.	Wound of temple	....	Recov'ed 30 days..	Philad. Med. Times, 1874.........	Hydrate of Chloral, 120 grains daily.
480	...	"	Wound of finger	....	Recov'ed	Chicago Medical Journal, 1874.	Injection of Solution of Hydrate of Chloral, 154 grains, into veins.

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ANALYSIS OF THE RESULTS OF TREATMENT IN FOUR HUNDRED AND TWENTY CASES OF TRAUMATIC TETANUS.

In the preceding tabulated statement of 420 cases of Traumatic Tetanus, treated by various methods and remedies, 207 terminated fatally, and 213 recovered; giving a mortality of 49.2 per cent.; or one death in 2.02 cases. This result is perhaps, more favorable than is actually the case in Traumatic Tetanus, as it occurs generally in civil and military practice; and the supposition is perhaps just, that in such a fatal form of disease, the tendency would be to record the successful, rather than the fatal cases, the reporters being actuated by a laudable desire to throw light upon its method of cure. By a comparison of the ratio of deaths to cases in the table, with the records of military and hospital practice recorded in the *Historical Notes on the Treatment of Tetanus*, it will be seen that the result was far less favorable than 49.2 per cent. of deaths, or one death in 2.02 cases. Thus the per cent. of deaths in the cases of Traumatic Tetanus which occurred in the British Army, in the Crimean War, was 91: in the Confederate (Southern) Army, 1861–1865, 91 per cent.; in the Federal (Northern) Army, 1861 to 1865, 92 per cent.; in Guy's Hospital, during a period of 32 years, 86.1 per cent. I have been unable to ascertain from the writings of Baron Larrey, the exact number of cases of Traumatic Tetanus, which came under his observation, but from all his statements, it would appear that the mortality of this disease in the French Armies, during the memorable and bloody wars of the great Napoleon, did not differ materially from that of British, Confederate and Federal Armies.

In instituting comparisons as to the rates of mortality in this disease in different countries, and under different circumstances, it should however, be remembered, that in military and naval service, we have in many cases, a much more serious and dangerous class of injuries, than those ordinarily met with in civil practice, and at the same time, the wounded are necessarily subjected to greater vicissitudes of temperature, and are often deprived of many of the appliances and remedies at the command of the civil surgeon and physician. Neither is it altogether just, to compare the results of Hospital service with those of private practice, because there are oftimes important differences in the patients treated, the hospital being supplied with subjects from the poorer and more abandoned classes. It will be observed however, that many of the cases recorded in the table, are drawn from hospital reports and military service.

From the preceding table we gather, that whilst tetanus may arise from almost every conceivable kind of injury, as contusions, fractures, abrasions of the surface, blisters, burns, frost-bite, ulcers, ligature of piles, caries of bones, gangrene, incised, punctured, lacerated and gun-shot wounds and amputation; at the same time, the rapidity of the supervention and the severity of the symptoms, bear no relation to the degree of the local injury. Thus out of 420 cases of Traumatic Tetanus, recorded in the table, 189 were caused by injuries of the feet and hands; that is, nearly one-half, or more accurately, 45 per cent. were due to comparatively slight injuries. The following cases illustrate the important fact, that comparatively slight injuries, may not only excite tetanus, but that the disease when thus induced is violent in its nature and rapid in its progress: Case 117,[1] Amputation of middle finger, followed by tetanus in 24 hours, and death on the 4th day after the appearance of tetanus; 121,[2] wound of sole of foot by rusty nail, tetanus 7th day, death 9th day after; 112,[3] fracture of little finger, tetanus 9th day, death 2d day; 124,[4] foot punctured by rusty nail, tetanus 7th day, death 3d day; 128,[5] laceration of hand, tetanus 13th day, death 15th day; 130,[6] lacerated wound of little toe, tetanus 10th day, death 14th day; 131,[7] lacerated wound sole of foot, tetanus 10th day, death 2d day; 132,[8] wound of fore finger, tetanus in 12 hours; 136,[9] contusion and fracture of metacarpal bones, tetanus 10th day, death 2d day; 138,[10] wound of foot by rusty nail, tetanus in 12 hours; 156,[11] sole of foot wounded with rusty nail, tetanus 5th day, death 4th day; 163,[12] lacerated wound of foot, tetanus 8th day, death 2d day; 166,[13] slight contusion of toe, tetanus 10th day, death 3d day; 169,[14] wound of thumb with splinter, tetanus 9th day, death 5th day; 170,[15] great toe penetrated with nail, tetanus 14th day, death 40 hours; 179,[16] sole of foot wounded with rusty nail, tetanus 13th day, death 20 hours; 189,[17] compound fracture of hand, tetanus 9th day, death 3d day; 195,[18] contusion of thumb of right hand, tetanus 9th day, death 2d day; 196,[19] sole of foot wounded with rusty nail, tetanus 8th day, death 5th day; 199,[20] laceration of little finger, tetanus 10th day, death second day; 206,[21] sole of foot wounded with rusty nail, tetanus fifth day, death second day; 211,[22] compound fracture of fingers, tetanus 10th day, death 24 hours; 216,[23] finger of left hand cut off by hatchet, tetanus in 2 hours, death in 12 hours; 218,[24] compound fracture of bones of thumb, tetanus 6th day, death 2d day; 220,[25] lacerated wound of thumb, tetanus 8th day, death 3d day; 230,[26] frost bite of toes, death 2d day; 233,[27] foot wounded by glass, tetanus 8th day, death 5th day; 243,[28] compound dislocation of astraglus and os naviculare, tetanus 7th day, death 2d day; 249,[29] little finger crushed, tetanus 8th day, death 3d day; 255,[30] laceration of index finger, tetanus 4th day, death 2d day; 256,[31] wound of sole of foot by rusty nail, tetanus 3d day, death 8th day; 257,[32] index finger crushed, tetanus 9th day, death 3d day; 261,[33] punctured wound of hollow of sole of right foot, tetanus 9th day, death 5th day; 262,[34] compound dislocation and fracture of fingers of right hand, tetanus 8th day, death 2d day; 268,[35] severe contusion and abrasion of back of hand, death from tetanus in 30 hours; 274,[36] index finger of right hand shattered, tetanus appeared immediately, and proved fatal in 32 hours; 290,[37] foot crushed by wheel of wagon, tetanus 6th day, death in 24 hours; 297,[38] puncture of sole of foot, tetanus 3d day, death 5th day; 298,[39] puncture of sole of foot, death 3d day; 299,[40] puncture of sole of foot, tetanus 7th day, death 3d day; 222,[41] splinter of wood in thumb of left hand, tetanus 12th day, death 3d day; 340,[42] wound of foot by splinter, tetanus 6th day, death 4th day; 342,[43] wound of ball of great toe with rusty nail, tetanus appeared in two hours; 343,[44] death in 24 hours after appearance of tetanus; wound of plantar surface of left foot by nail, tetanus 7th day, death 4th day; 381,[45] injury of nail of thumb, tetanus 7th day, death 3d day; 382,[46] wound of hand by splinter, tetanus 14th day, death in 24 hours; 384,[47] wound of palm of hand with spiculæ of bone, tetanus 21st day, death 4th day; 390,[48] compound dislocation of thumb, tetanus 5th day, death in 32 hours; 391,[49] amputation of toes, tetanus 10th day, death in 48 hours; 431,[50] injury of fingers, tetanus 13th day, death 4th day. In the preceding 50 cases, in which traumatic tetanus was caused by comparatively slight injuries of the extremities, 48 proved rapidly fatal, or 96 per cent.; and of the whole number of deaths (207), recorded, 24.14 per cent. of the entire number were caused by tetanus, which ran a rapid course after slight injuries; whilst of the entire number of cases, 420, this special class of cases formed only 11.9 per cent. Case 348 illustrates the fact that even so slight an operation as vaccination may give rise to tetanus; case 355 demonstrates that the sub-cutaneous injection of Quinine may prove fatal from traumatic tetanus in 30 hours; and in case 373 it is shown that the operation of ligation of the piles may be followed by tetanus and terminate fatally on the 2d day.

It will also be seen that the time at which the symptoms of tetanus supervened after the reception of the injury, varied within wide limits; in some cases the disease was developed almost immediately after the reception of the injury, whilst in others, weeks elapsed before the appearance of trismus and tetanic spasms; and as a general rule, the more sudden and rapid the onset of the disease after the receipt of the injury, the more fatal was the result. Thus in the five cases reported by Hippocrates, two appeared to have been attacked with the disease within 24 hours after the reception of the injury, and one proved fatal on the 2d day, and the other on the 3d day; a case reported in the Medical Gazette, as occurring on the day following the injury, proved fatal on the 2d day; a case reported by Dazelle as occurring on the 3d day, terminated fatally on the same day; in a case reported in the Dic. des Scienc: Medicales, the symptoms appeared in two hours, and the patient died in twelve hours; in a case reported by J. B. Thompson, tetanic symptoms appeared immediately after the shattering of the index finger, by the falling of a barrel, and the patient died in thirty-two hours; in the case reported by Dr. Brady, the symptoms appeared in twenty hours, and death followed in seventy hours, and in another case reported by the same observer, the symptoms appeared on the following day, and the patient died in twenty-four hours.

At the same time, some of the severest and most rapid cases occurred, when an interval of more than nine days had elapsed after the reception of the injury, as in cases, 100, 102, 115, 119, 122, 131, 135, 136, 138, 146, 147, 148, 149, 158 159, 166, 170, 179, 193, 199, 211, 237, 244, 245, 282, 308, 355, 373, 382, 385, 386, 391, 392, 397, 404, 424, 431, 437, 438, 443, 446, 456, 458.

After a careful examination and comparison of the different methods of treatment, recorded in the preceding table, whilst it will be found to be impossible from the heroic use of the most powerful remedies and poisons, as well as from the constant interchange of the remedies, without any apparent reason or system, to determine whether the relief should be ascribed to one or more remedies, or to the natural powers of the patient, which owing to the peculiar nature of the nervous excitement, resisted successfully the action of the most powerful drugs and the effects of this terrible disease; at the same time, the table abounds with facts, illustrating the value of certain remedies and general principles of treatment.

Case 263, treated by the injection of tartar emetic into the median vein, and case 394, treated by sub-cutaneous injection of woorara, were evidently and directly destroyed by the measures instituted by the attending physicians.

Our knowledge of the therapeutics of Traumatic Tetanus, would be extended, if it were possible to classify with any approach to accuracy, the cases in accordance with definite plans of treatment, or with the individual remedies employed, but for the reason just assigned, this is to a great extent impossible; but we may express the hope, that the medical officers of armies and navies, and civil and military hospitals, will as far as possible, institute definite plans of treatment, and test thoroughly by carefully recorded observations, the relative value of those remedies which are employed with most confidence and frequency in the treatment of this disease. If such practical investigations be at the same time combined with careful observations on the symptoms and pathology, it is but reasonable to believe that the doubt and uncertainty which has, throughout the entire history of Medicine, involved the therapeutics of this dreadful disease, will be gradually, but surely dissipated, and physicians will be enabled to adopt, with some approach to certainty, that plan of treatment which will promise the highest and best results to the patient.

The following practical conclusions may be drawn from the preceding facts:

1. An important advance in the treatment of Traumatic Tetanus would be made if it were possible to institute efficient measures for the arrest of the disease in its earliest stages. Lassitude, restlessness, great depression of spirits, an uneasy sensation about the præcordia, cold chills, and an uneasiness about the throat, leading the patient to imagine that he had caught cold, slight stiffness of the muscles of the jaw, and twitchings of the muscles of the injured limb, have justly been regarded as premonitory symptoms of this disease, and it is important that decided and efficient measures should be devised for the aversion or arrest of the attack.

Recently the following case came under my treatment in private practice, in which an opportunity was afforded for the institution of measures designed to arrest the first symptoms of Traumatic Tetanus.

Case 481.—A gentleman, age 36, whilst stooping down in his yard with a hen in his hand which he had just caught, was attacked by a spirited game cock, which drove one of his long, sharp spurs into the posterior surface of the fore-arm, in the muscular space between the ulnar and radius, just below the elbow-joint. The arm commenced to swell immediately, and in twelve hours the patient suffered severe pain in the injured arm, with twitchings of the muscles. Upon the following day the nervous symptoms increased, with lassitude, restlessness and great depression of spirits. Upon the evening of the second day the patient complained of uneasy sensations in the throat, with twitchings of the muscles of the jaw, arm and leg of the side upon which the injury had been received. In attempting to walk the spasms were so severe as to turn the patient violently around, and almost to throw him down.

The local application of the Tincture of Iodine, and the introduction of a tent smeared with Iodine ointment into the wound, (during this operation the patient fainted), established free suppuration, and by the counter irritation of the Iodine relieved the pain in the region of the nerves leading from the wound.

Hydrate of Chloral administered in doses varying from ten to thirty grains at regular intervals of from one to four hours, relieved the spasmodic affection of the muscles, and full doses of opium at bed time induced quiet sleep; and under this treatment, at the end of ten days, all symptoms of Tetanus disappeared.

A similar plan of treatment was successfully pursued by the author in the case of his own child, Fannie Polk Jones, æt. four years, who was bitten June 10th, 1875, by a pet dog, just above the knee of the right leg. On the third day, alarming symptoms appeared, as great rigidity of the muscles of the right leg and thigh, which extended rapidly to the left lower extremity, causing firm flexion of the limbs and preventing locomotion. The sleep was disturbed, and the child emitted a piercing shriek whenever I touched the wounded leg. On the second night slight spasms were noticed in the muscles of the upper and lower extremities, and during sleep the thumbs were firmly flexed. I administered four grains of Calomel, and followed it with Castor Oil in six hours, and thus evacuated the bowels. Tincture of Iodine was freely applied to the wound, and followed with flaxseed poultices mixed with oil of Turpentine and Laudanum. Laudanum and Bromide of Potassium were also administered internally after the bowels were evacuated. The poultices were large and renewed every 4 or 6 hours. Under this treatment the spasms entirely disappeared in the course of 5 days.

The local measures which appear to be most suitable for the arrest of Tetanus in the earliest stages, are:

a. Counter irritation, with the Tincture of Iodine and Ointment of Iodine applied within and around the wound. This application should be followed by warm poultices of flaxseed or bread and sweet milk, to which Tincture of Opium should be added. The poultices will in like manner tend to promote suppuration in the wound. During the past twenty years I have used with good results the Tincture of Iodine as a local application to such wounds of the extremities as are known to be most frequently followed by Traumatic Tetanus, as penetrating wounds of the hands and feet inflicted by splinters, glass and rusty nails. When poured directly into the wound, even within a few moments after its reception, it produces no increase, but rather a diminution of pain. The application should be repeated every day, or every other day, as long as the wounds are painful and inflamed. In dissecting wounds also I have found no agent superior to the Tincture of Iodine for the arrest of the poisonous action. In some cases a saturated solution of Carbolic Acid in Alcohol may be used as a local application immediately to the wounded surfaces. An ointment composed of two drachms each of the Tincture of Iodine, saturated solution of Carbolic Acid in Alcohol, and Tincture of Opium, mixed thoroughly with from one to two ounces of Simple Cerate, has proved in my hands a useful application to wounds of this description.

An efficient sedative application to the surface of the injured extremity and to the back over the region of the spine, will be found in a liniment composed of equal parts of Chloroform, Gum Camphor and Tincture of Opium, mixed with from two to four parts of Olive Oil. The Camphor should first be dissolved in the Chloroform and this solution mixed with the Tincture of Opium and Olive Oil. The injured limb may be rubbed with this, and also enveloped in a piece of soft lint saturated with it.

b. THE CAREFUL REMOVAL OF ALL FOREIGN BODIES FROM THE WOUND.—The importance of a thorough examination of the wound and the removal of all foreign bodies, was forcibly illustrated during the recent civil war, by the following cases, which were treated in the General Hospital, at Charlottesville, Virginia:

In the first case, after death, a piece of the leather cartridge box was found buried in the triceps muscle. The ball had passed through the arm; the probe in like manner passed readily through from the point of entrance to that of exit, and hence the extraneous body was not discovered during life. In this case the spasms appeared at first to be confined to the muscles of the arm, and Dr. Cabell at first supposed that it was a case of "traumatic spasm." The spasms were confined to the wounded arm for two or three days before they affected the general system. The second case manifested local spasms similar to those of the case just recorded, the spasms being confined to the wounded limb. After the removal of a piece of cloth from the wound of the leg, the patient recovered. It appears to be a fair inference that if, in the first case, the piece of leather had been removed from the arm before the spasms became general, the patient would, in like manner have recovered. Such cases support, in the clearest and strongest manner, the theory that traumatic tetanus is primarily, in its earliest stages, dependent upon local lesions of the nerves, the irritation being gradually propagated to the segment of the cord with which the injured nerve is connected, and from thence propagated to the ganglionic cells of the entire spinal axis.

c. Actual Cautery.—The application of the actual cautery to the wounded surface appeared to be attended with beneficial results in certain cases of traumatic tetanus, and Baron Larrey was the most strenuous advocate for its use. Cases 95, 96, 97, 98 and 99 illustrate the beneficial effects of the actual cautery. It is probable, however, that the Tincture of Iodine, and the saturated solution of Carbolic Acid in Alcohol will accomplish as efficient and satisfactory results, and with less pain and inconvenience to the patient. In case 342, the application of the actual cautery (a heated poker pressed into the wound), was said to have been attended with a sensation of pleasure rather than of pain, the patient exclaiming, "What are you doing? Delightful! You make me feel as if I were in heaven!"

d. Section of the Injured Nerve, Amputation, and the Application to the Wound or Cicatrix of the Actual Cautery, have, when employed in the earliest stages, before the spinal axis has been seriously involved, been attended with apparent benefit in arresting the farther progress of the disease.

Such measures are only valuable when the irritation is chiefly confined to the injured nerve. After the irritation has been fully established in the spinal axis, it is doubtful whether amputation, section of the nerve and the actual cautery will materially alter the progress of the disease. We have carefully recorded the historical facts relating to section of the nerves and amputation, as proposed by William Cullen and practised by G. Hicks, Baron Larrey and others. (See cases 60, 91, 93, 94, 112, 118, 132, 135, 172, 178, 181, 228, 257, 266, 329, 338, 343, 345, 356, 361, 367, 370, 371, 372, 385, 402, 447, 470). In the employment of such measures, the physician must be governed by the general symptoms, as well as by the nature and position of the wound.

2. Absolute rest of the injured part; and quiet rest of the patient in a dark room of regulated temperature. All draughts of cold air, and all extremes of heat and cold, as well as sudden changes should be avoided. The strictest quietude should be insisted upon. If the patient has been accustomed to the use of tobacco in any form or mode, it should not be discontinued. It is evident that in certain cases the severity and violence of the tetanic spasms and contractions, will preclude the use of Tobacco in chewing or smoking.

3. The bowels should be kept open by efficient purgatives, as Croton Oil, Calomel, Castor Oil, Epsom Salts, and the compound Cathartic pill of the United States Pharmacopœia. The action of the purgatives may be promoted by the use of Enemas. Infusion of Tobacco may with benefit be combined with the clyster. A simple, but efficient enema may be quickly and extemporaneously prepared, by mixing one fluidounce each of Castor Oil and Molasses, half an ounce each of common Salt and Sulphate of Magnesia, and one drachm of Turpentine with one pint of tepid water. If the infusion of Tobacco be employed as the vehicle for the purgatives administered by the rectum, half a drachm of the dried leaf, should be boiled in a pint of water and strained. The purgatives above indicated may be added to the infusion of Tobacco, or it may be administered alone. The infusion of Tobacco may be employed twice or three times

daily, but its effects should be carefully watched; and its depressing action upon the heart and circulation generally, counteracted by stimulants and nutritious diet.

4. The strength of the patient should be sustained throughout the disease, by simple but nutritious diet, consisting chiefly of milk, milk punch, beef tea, egg-nog, boiled milk and rice, arrow root and thick corn and rice gruel.

When Traumatic Tetanus is fully developed, the physician should ever bear in mind the important facts, that the greatest sources of danger are from sudden arrest of respiration from spasm of the respiratory muscles and epiglottis, and from the continuous and progressive exhaustion of the powers, consequent upon the continuous expenditure of the nervous and muscular forces, the loss of refreshing sleep, and the imperfect nutrition of the body, consequent upon the great difficulty in many cases, of taking nourishment. In those rapid cases which prove fatal, in the course of from one to four days after the onset of the disease, the cause of death is most generally *asphyxia;* and in every case of Tetanus the favorable or unfavorable issue will depend to a great extent upon the set of muscles involved. It should also be carefully borne in mind that the chances of recovery increase with every day of prolonged life. The powers of the patient should therefore, be continuously and carefully supported by nutritious diet, (administered freely by the rectum in the form of beef tea, if the patient is unable to swallow), and alcoholic stimulants; when asphyxia occurs, artificial respiration after the method of Marshall Hall, should be instituted.

5. In the constitutional treatment of Traumatic Tetanus, those remedies should be employed, which exert the most decided sedative effects upon the spinal system, and which promote in the most efficient and least injurious manner profound sleep.

The excitement of the nervous system may be controlled and subdued, and the tetanic spasms overcome, and sleep promoted by the free and continuous use at short intervals of such remedies as Opium, Morphia, Tobacco, Extract of Indian Hemp, (Extractum Cannabis Indicæ), Calabar Bean, Sulphuric Ether, Chloroform and Hydrate of Chloral and Bromide of Potassium.

It will be observed that Opium was used in conjunction with other remedies in the majority of the cases recorded in the table; and on this account it is difficult, if not absolutely impossible to estimate fully its value in the treatment of Tetanus. It certainly fails in many cases to alleviate or to arrest the disease, and it may be a question whether the enormous doses in which it has been used in the treatment of this disease, may not have increased the rate of mortality. Opium may be administered with good effects in conjunction with the Hydrate of Chloral, in doses varying from half to one grain, every two, three or four hours. The action of the solid Opium in pill is to be preferred to that of the tincture or fluid extract, as it is more uniform, and diffuses itself over a longer period of time. The dose of the Hydrate of Chloral should be carefully regulated in accordance with its effects, and the peculiarities of the constitution of the patient. In most cases from 10 to 60 grains, at regular intervals of one, two, three or four hours, according to the urgency of the symptoms, will be found to produce efficient results. Bromide of Potassium has been combined with the Chloral Hydrate, with apparent benefit. Alcoholic Stimulants may be employed in conjunction with Opium, Hydrate of Chloral, Chloroform and other remedies, with benefit, especially if given in sufficient quantity to produce sleep. Pure Alcohol, properly diluted, is perhaps, preferable to the more common liquors vended in immense quantities and largely adulterated with highly injurious and even poisonous substances.

We propose to consider briefly the therapeutic action in Tetanus, of those remedies, which appear to fulfil the conditions indicated, in the most efficient manner.

The preceding record of 420 cases of Tetanus, arranged very nearly chronologically, affords conclusive evidence that important advances have been made in the treatment of Traumatic Tetanus; thus, if the table be divided into two equal portions in the first 210 cases recorded, the recoveries numbered 91 and the deaths 119, giving a per cent. of 59.0 deaths, or one death in 1.77 cases: in the second series of 210 cases, the recoveries numbered 122 and the deaths 88, giving a per cent. of 41.9 deaths, or one death in 2.38 cases.

In the first series of 210 cases which brought the clinical history of Traumatic Tetanus down to or about the close of the year 1840, the chief remedies employed were, Blood-letting, Mercury, Opium, Tobacco, Belladonna, Turpentine, Croton Oil, Tartar Emetic, Camphor, Musk, Assafœtida, amputation, section of nerves, irritant and caustic applications, blisters, actual cautery and cold affusion. The most valuable remedy in this series appears to have been Tobacco administered in the form of infusion by the rectum, its introduction into the mouth being most generally precluded from the nature of the cases, and from the spasms which it is known to excite in some cases, when thus administered.

In the second series, the most important additions to the remedies previously used in the treatment of Traumatic Tetanus, were Chloroform, Ether, Indian Hemp, (Cannabis Indica), Calabar Bean and Hydrate of Chloral, and Bromide of Potassium.

Both series of cases include the records of Military and Civil Hospitals, as well as those of private practice.

The diminished rate of mortality in Traumatic Tetanus appears to be referable chiefly to the following causes:

1. Improvements in the Hygiene and sanitary condition of the sick.
2. Simplification and improvement of the local measures.
3. Increased attention to the support of the powers of the patients, by nutritious diet and alcoholic stimulants.
4. The free use, at regular intervals and in accordance with the nature and severity of the symptoms, of such remedies as Cannabis Indica, Calabar Bean, Chloroform and Hydrate of Chloral.

Chloroform.—In the first case reported, we were led to attribute the favorable issue chiefly to the Chloroform administered *internally*. The Sulphuric Ether and Opium were, without doubt, beneficial, especially as the strength of the patient was supported by nutritious diet and stimulants. It would appear that Opium and Chloroform mutually aid each other when given in conjunction in traumatic tetanus. The researches of Professor Claude Bernard, at the Collége de France, have shown that Morphia and Chloroform may be administered with benefit in combination or alternately. As it is of the utmost importance that the strength of the tetanic patient should be maintained by every means, and especially by refreshing sleep, the physician should be careful to devise the most efficient means for the furtherance of this end. According to Professor Claude Bernard, Morphia produces sleep, but at the same time it brings on a peculiar state of excitement. If Chloroform is inhaled by an animal previously narcotized by the alkaloid, only an extremely small dose is necessary to produce anæsthesia. On the other hand, the injection of a solution of Chlorohydrate of Morphia in an animal which has been set to sleep by Chloroform, and is beginning to awake, restores insensibility. This fact has been demonstrated by numerous experiments. In attempting to explain this theoretically, Professor Bernard admits that the sensitive cellule must be in contact with blood mixed with a certain quantity of Chloroform, in order that anæsthesia may take place. As the anæsthetic substance is being constantly eliminated, sensibility shows a tendency to recur, but Morphia prevents sensibility, just in the degree necessary for the production of anæsthesia by the Chloroform which is left. On the other hand, if Chloroform protracts and re-establishes the somniferous action of Morphia, at the time when it ought normally to cease, it is because the sensitive irritability, which is the source of reflex action, being heightened by Morphia, places the animals in a condition of impressionability peculiar to Chloroform. The action, at once somniferous and exciting in Morphia, does not appear to Claude Bernard to justify the view of a double substance contained in the alkaloid, and producing this two-fold effect; he believes in the chemical unity of Morphia, and explains this double effect by two stages of the same physiological action, which may vary in duration or intensity, and thus produce certain differences.

It will be found, upon examination of the preceding table, that Chloroform was used in the following cases: 293, 294, 295, 305, 308, 309, 311, 314, 317, 325, 331, 332, 334, 335; 336, 337, 350, 353, 354, 355, 357, 358, 359, 373, 378, 382, 383, 384, 385, 386, 388, 393, 395, 396, 429, 432, 434, 435, 438, 447, 452, 453, 457, 459. Of these 45 cases, in which Chloroform was employed chiefly by inhalation, and in conjunction with other remedies, 24 were cured and 21 terminated fatally. Even in the fatal cases, the pain was relieved, and the severity of the paroxysms greatly mitigated. This result would have been much more favorable if a large proportion of the cases had not occurred in military practice; but notwithstanding this, the rate of mortality under the use of Chloroform was less than 50 per cent., or more exactly, 46.6 per cent. After a careful examination of the effects of Chloroform, administered in Traumatic Tetanus internally and by inhalation, we have arrived at the conclusion that this agent is far more efficient and safe when administered internally.

That Chloroform rapidly exhausts the powers of the nervous and muscular system when administered by inhalation, and that this effect is produced more rapidly than by sub-cutaneous injection, was illustrated by a series of experiments which I instituted on various animals, and from which I extract the following:

Experiment 186: Illustrating the Action of Chloroform on Warm-blooded Animal, by Sub-Cutaneous Injection and Inhalation.

Augusta, Ga., June 16, 1860: Large, well conditioned cur dog. Temperature of atmosphere, 79° F.; temperature of rectum of dog, 40°.66 C. Action of heart in a state of rest, 66 per minute; respiration, 20 per minute. When first tied and secured for the experiment the dog made violent struggles; the thermometer was introduced into the rectum just after these struggles, and indicated the temperature given above; the dog, after being securely tied upon the operating table remained quiet, and the thermometer in the rectum slowly descended to 40°.62 C., and remained stationary at this point.

Two and a half fluidounces of Chloroform were injected into the sub-cutaneous tissue of the right thigh and fore leg of the same side. Simultaneously with the injection of the Chloroform the dog commenced to struggle. During these struggles there was a rise in the thermometer, and 25 minutes after the injection of the chloroform, the temperature of the rectum was 41° C., showing a rise of 0°.38 C. after the injection of the Chloroform. 40 minutes after the injection of the Chloroform, the dog was restless, barked and growled. Action of heart increased, 120 beats per minute; respiration 12 per minute, full and labored, and occasionally stertorous. Temperature of rectum, 41°.1 C. Chloroform to the amount of one and a half fluidounces was again injected into the sub-cutaneous cellular tissue of the legs, without producing coma or any marked change. The dog was then released from the operating table; he rose and walked, and although weak and tremulous, appeared to have the exercise of the cerebral functions. This appeared to be remarkable, as four fluidounces of Chloroform had been injected into the cellular tissue of the right thigh and leg.

One fluidounce more of Chloroform was injected into the cellular tissue of the fore and hind legs, without producing coma, and the dog was still able to walk about; he appeared weak, but not at all insensible, and could not be induced to lie down. Occasionally there was a sudden giving way of the legs, as if the dog would fall down, but this was momentary, and the muscles appeared immediately to regain their strength. The temperature of the rectum fell during the last 35 minutes, 0°.2 C., and now stood at 40°.9 C. At this moment, 75 minutes after the first injection of the Chloroform, a sponge saturated with Chloroform was held before his mouth; the effects were almost instantaneous; in less than one minute he became insensible, notwithstanding that when the sponge was first applied his struggles were of the most violent character. After the establishment of the coma, the action of the heart was 112 per minute and very feeble; respiration 50 per minute, quick and short; in 10 minutes after the commencement of the inhalation of the chloroform, the action of the heart and the respiration had ceased; the temperature of the rectum had remained stationary during the short period of coma, and at the moment of death stood at 40°.9 C. The temperature of the rectum commenced to descend a few moments after the cessation of the action of the heart and lungs; the descent was very slow, almost imperceptible at first, and in 27 minutes after death, stood at 40°.6 C.; 75 minutes after death, temperature of rectum, 39°.9 C.; 195 minutes after death, 38°.4 C.

Autopsy 195 *minutes after death.*—The blood, after death, presented a cherry red color, and coagulated perfectly after its abstraction, in two minutes, and the coagulum was firm. On exposure to the atmosphere the blood rapidly changed to a bright arterial hue; under the microscope the blood corpuscles presented a normal appearance; in some instances they assumed a stellate shape. Rigor mortis complete. Interrupted magneto-electric currents had no effect upon the voluntary and involuntary muscles. Muscles of all parts of the body of a deep red, purple and crimson color, and filled with blood; when cut the blood poured from the cut muscles. Blood-vessels of brain filled with blood. No coagula were found in the blood-vessels of the brain. Blood-vessels of messentery filled with dark blood. Bladder distended with urine. Mucus membrane of stomach and intestines redder than usual. Lungs considerably engorged with blood, but much less so than the lungs of a dog killed at the same time by a rattlesnake. The appearance of the muscles of the dog killed by chloroform were in striking contrast to that of the dog killed by the poison of the rattlesnake, which, although almost entirely bloodless, were of a dark purplish and bluish purple color. Whilst the blood streamed from the cut surface of the muscles of the former, no blood whatever issued from the muscles of the latter.

Experiment 187: Illustrating Action of Chloroform.

Augusta, Ga., June 16th, 1860. Subject of experiment, small kitten, two months old. Temperature of atmosphere, 81° F.; of rectum of animal, 39°.4 C. Administered chloroform by inhalation. The kitten became insensible in a few seconds. The temperature of the rectum began to descend immediately after the establishment of the coma, and in 4 minutes after the first inhalation, stood at 39° C. The action of the heart and the respiration ceased 4 minutes after the inhalation of the chloroform.

53 minutes after death, temperature of rectum, 35°.2 C.; 183 minutes, 31° C.

The microscopical examination of the blood after death, revealed no distinct alterations in the blood corpuscles. The colored blood corpuscles in this young animal were distinctly nucleated.

Experiments 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200: repetition of preceding experiments, with similar results.

When administered by inhalation, Chloroform is rapidly absorbed by the pulmonary surface, enters the blood, and is conveyed in a very few moments to the central nervous ganglia, and exerts an almost immediate effect upon the ganglionic cells. In most cases, when the inhalation ceases, the effects, when fresh air is freely supplied, pass off in a comparatively short space of time. In some cases, however, obstinate vomiting, with complete loss of digestive power, and great prostration of the muscular and nervous systems, continue for periods of time varying from a few hours to thirty-six hours. In experiments which I have instituted upon myself, with the inhalation of Chloroform, the nausea, vomiting, and nervous prostration, has frequently continued for more than twenty-four hours. In my own case, Chloroform, when inhaled, appears to produce great irritation of the mucus membrane of the stomach, attended with the most distressing nausea, and the vomited matter consists of a clear acid mucoid fluid, often discolored by bile.

When Chloroform on the other hand is administered internally, it is slowly absorbed, and its depressing effects upon the cerebro-spinal nervous system, are less violent and at the same time more lasting.

As Chloroform exeres a powerful sedative effect upon the brain, induces anæsthesia or insensibility to painful impressions, and if in sufficient quantity, deep sleep or coma, with complete muscular relaxation, it is evident that it is eminently adapted to counteract the state of ganglionic excitement of the spinal system with the greatly exaggerated reflex actions, characteristic of Traumatic Tetanus. And it would appear that in this disease, much larger doses may be borne with impunity than in any other malady, with the exception, perhaps, of Hydrophobia and certain forms of Neuralgia, attended with incessant pain. In a case at Guy's Hospital, of painful neuralgia, more than one pint of Chloroform was used in twenty-four hours. It should, however, be borne in mind, that this remedial agent sometimes arrests the action of the heart, or in some other manner suddenly destroys life; and also, that when used freely by inhalation, without proper attention to the admission of air into the lungs, it may accumulate in the blood, and also cause the accumulation of carbonic acid in this fluid, and thus gradually, but surely undermine the vital powers. And even in those cases, in which Chloroform appears evidently to check the progress of tetanus, and to relax the muscles, we must administer it with due caution. It is desirable in Tetanus, to preserve the strength by the most efficient and judicious means, on the ground, that every day of prolonged life gives renewed hope of final recovery.

When given internally, in doses of from thirty to seventy drops, Chloroform appears to produce no excitement of the brain, or increase of the action of the heart, but is sedative to the nervous and circulatory systems, inducing a pleasant calmness with cerebral confusion and a feeling of drowsiness. When taken in a large dose, it appears to affect the system like alcohol. In a case recorded by Dr. Alfred Swaine Taylor, in which a man swallowed four ounces of Chloroform, he was able to walk for a considerable distance after taking this dose, but subsequently fell into a state of coma—the pupils were dilated, the breathing stertorous, the skin cold, the pulse imperceptible, and there were general convulsions. He recovered in five days. (Med. Gaz., vol. xlvii, p. 675). M. Aran, has recorded a case in which a quantity, supposed to be from eight to ten drachms, was swallowed in mistake by a man; the first symptoms were a burning sensation, with ineffectual efforts to vomit; in a few minutes afterwards, he was found with his eyes glistening, his features animated, singing and talking incoherently, and unable to recognize those about him. There were some convulsive movements; the skin was insensible to painful impressions; sight was lost; and the pulse was between seventy and eighty. In the course of twenty or thirty minutes sleep ensued, which became very deep, and was attended with insensibility of the surface, and complete relaxation; the respiration and circulation remaining normal. The sleep continued several hours. Next day he could remember nothing of what had passed, and the unpleasant symptoms gradually disappeared. (Bull. de Thérap., xlii, 296). A private in a Cavalry regiment in the United States Army, swallowed nearly two ounces of Chloroform. He was seen ten or fifteen minutes afterwards; he had already vomited, and was found insensible, with stertorous breathing, and a pulse of about 60. The pulse became more feeble, the breathing slower and the pupils more insensible to light. The surface became cold, and for a time he continued to get worse, the face becoming purple, while the pulse was intermittent and hardly discernible. Two hours and a half after taking the poison, however, a gradual improvement commenced, but sensibility did not return until four hours later. For several days, he continued to suffer from great irritability of the stomach, and eventually he had an attack of jaundice. (Am. Jour. Med. Sci., October 1857, p. 365).

Alarming symptoms and even death have been produced by much smaller doses. A lady swallowed half an ounce of pure Chloroform; in five minutes she was quite insensible, generally convulsed, the jaws clinched, the face slightly flushed, the pulse full and rather oppressed, and she foamed at the mouth. She vomited, and in twenty minutes the convulsions had left her; soon afterwards she had a relapse, and did not recover for twenty-four hours. (Med. Times and Gaz., 1867, p. 615). In a case reported by Dr. Taylor, a boy who had swallowed a *drachm* of Chloroform, lost all consciousness, in a short time became insensible, cold and pulseless, and died in three hours, quite calmly, without a struggle, in spite of every effort made for his recovery.

If one drachm be the smallest dose which has been known to destroy life, and that in the case of a child only fonr years of age, it is evident that it is much less potent in its effects when administered internally; for in one instance, the patient died in one minute, in which only *30 drops* had been inhaled in vapor, and in another, so small a quantity as fifteen or twenty drops, proved speedily fatal. These quantities are relatively small, when it is remembered that the cohesion between the particles of Chloroform is so feeble, that it yields a greater number of drops from a certain measure, than any other medicinal liquid; one fluid drachm yielding on an average 240 drops. With the exception, perhaps of Prussic Acid, Chloroform operating through the lungs, has destroyed life more rapidly and in smaller dose than any poison known; and from the fact just recorded it appears to be at least *ten times more potent*, when administered by inhalation than by the stomach. According to Dr. B. W. Richardson, of London, the proportion of deaths from Chloroform will be about one in 1500 to 2000 cases of its administration by inhalation. Dr. Richardson recognizes only one bodily condition, as a distinct source of increased risk in the administration of Chloroform by inhala and that is, a heart with its right ventricle dilated, and attended with bronchial and dilatation of veins. Experiments have shown that the anæsthetic left the unaffected, and that its action is upon the nervous centres. (Lancet, June, 187 329).

In the treatment of such a disease as Tetanus, in which it is necessary, not only make a decided impression upon the cerebro-spinal system, but also to sustain impression for days, and even weeks, it is best to employ Chloroform by internal istration. At the same time we have recorded facts to show that it must be with caution, even in this comparatively harmless mode. It is now fortunate comparatively soluble and tasteless substance, capable of yielding Chloroform by decomposition in the blood, is within the reach of every physician for the treatment of Traumatic Tetanus. In the employment of Chloroform and Hydrate in Traumatic Tetanus, it should be borne in mind, that in the primary sions upon the nervous centres of animal life, sensibility to pain is abolished consciousness, and a decided effect upon the ganglionic cells of the spinal cord may produced without any suspension of consciousness.

The vehicle in which Chloroform is administered in Tetanus should be selected, for if it be given in simple water, a portion sinks to the bottom of the and when administered, makes a disagreeable impression, and also may excite the sudden irritation of the fauces, throat and epiglottis. It may be administered the form of emulsion, the Chloroform being rubbed first with four parts of Olive Oil, and then incorporating this mixture with water, by the intervention mucilage of gum Arabic and sugar or syrup, in the ordinary form. Chloroform also be suspended in water, by means of the yolk of egg, and syrup of Orgeat. (Syrup Amygdalæ).

When one part by weight of Chloroform is mixed with eight parts of Alcohol, resulting solution forms stable solutions with water, wines or syrup; and this specially useful in Tetanus, as the alcohol is not contra-indicated. I have thus Chloroform in the treatment of this disease. Glycerine also forms an admirable for the administration of Chloroform; a mixture composed of equal parts readily dissolves in water.

When used hypodermically, Chloroform quickly allays pain, quiets spasm induces sleep; but the objection to this mode of medication is, that it tends to to local inflammations, attended with pain, redness, swelling, and tenderness on

As a local application, and counter-irritant, applied freely along the spine, has proved efficacious in Traumatic Tetanus, and also in the Tetanus of children (Trismus Nascentium.) In the cases demanding frequent local and especially in the Trismus of infants, it may be used advantageously in with Camphor and Olive Oil, thus: ℞. Chloroformi f℥i; Pulv. Camphoræ ℥ss; Olivæ f℥iii: dissolve the Camphor in the Chloroform, and mix with the Olive Oil; as a local application to spine and injured extremity, repeating at short intervals, also applying by means of lint and flannel saturated with the mixture.

Sulphuric Ether.—The tendency of Chloroform to depress the vital powers, may measure be counteracted, by combining it with Sulphuric Ether, for whilst this agent in moderate doses as a diffusible stimulant, at the same time it has a similar Chloroform, in producing Anæsthesia, and relaxation of muscular spasm, and of the reflex function of the spinal cord.

Sulphuric Ether in conjunction with other remedies was employed (chiefly by *tion*,) in cases 87 and 88, 244, 248, 291, 292, 295, 299, 300, 301, 302, 303, 330, 335, 453. Of these 17 cases, 10 were cured and 7 died, giving a forty-one per cent, or one death in 2.42 cases.

Sulphuric Ether may be administered in Traumatic Tetanus, either internally inhalation. It is well known that this agent is capable of producing complete of the nerves of sensation; and this result is especially valuable in the

Tetanus, in which disease, the slightest impression upon the nervous system, even by a touch or current of air, or a sound, is capable of exciting violent spasms.

In some cases of Tetanus, it is impossible from the firm closure of the jaws, and from the excitation of spasms, by the local stimulant effects of Chloroform and Ether upon the mouth and fauces, to administer these remedies internally; and in such cases good can be expected from these agents, by inhalation alone. When Chloroform has been used, even after relief has been obtained from suffering, the patient has died from nervous prostration, and as debility is one of the great dangers of Tetanus, it is best to combine Sulphuric Ether with Chloroform, in order that the stimulant action of the former may overcome or counteract the direct sedative or depressing effects of the latter.

Whilst the number of deaths caused by the inhalation of Sulphuric Ether, are much less than those by Chloroform, at the same time, it is important, in the treatment of such a disease as Tetanus, in which large quantities may be necessary to effect even an amelioration of the symptoms, to remember, that this agent may cause death, by the direct poisonous action of the absorbed vapor upon the nervous centres and heart, and by improper æration of the blood, and the accumulation of impure blood in the brain and heart, loaded with Carbonic Acid.

That Ether may prove rapidly destructive, by its direct action upon the nervous system, independent of its action upon the blood, is evident from the results of the following Experiments, which I performed in order to compare the effects of this agent with those of Chloroform.

Experiment 201: Illustrating the effects of Sulphuric Ether by Inhalation.

Augusta, Ga., January 28th, 1861. Large cur dog, subjected to inhalation of Sulphuric Ether. The effects resembled those often observed in human beings. At one time the dog growled, and barked, and endeavored to bite; then he whined, and moaned, and struggled violently. Although more than five fluidounces of Sulphuric Ether were poured upon the sponge which surrounded the nose of the dog, during the space of one hour, coma was not induced. The dilatation of the pupils was amongst the first effects produced by the Ether. After subjecting the dog to the action of the Ether for one hour, he was released, and placed upon the floor; he was unable to stand; endeavored to rise, and fell heavily upon his side; all the muscles were in a tremulous motion, and when he would attempt to rise, his motions appeared to cost him the exertion of all his strength, and after the most persistent effort or series of efforts, having regained his feet, the muscles of the limbs would suddenly give way, and down would fall the dog, as if struck by lightning. These effects gradually disappeared, and at the end of one hour, the dog was able to get up and walk about. In the efforts to rise, the trembling of the muscles, and the want of coördination of the muscular motions, indicated clearly the action of the Ether on the motor cells and reflex function of the spinal cord.

Effects on the Temperature.—Temperature of atmosphere 46° F. Temperature of rectum of dog, before the inhalation of the Ether, 39°.6 C. The temperature of the rectum remained stationary until the pupils of the eyes were dilated, and then, in ten minutes after the first inhalation, commenced very slowly to descend, and in fifteen minutes fell 0°.2 C., and in 15 minutes more lost 0°.2 C.

Notwithstanding the struggles of the dog, the temperature still continued steadily to descend, and at the end of one hour after the first inhalation, stood at 38°.6 C., showing the loss, during this time, of one degree centigrade. As soon as the inhalation of Ether was discontinued, and the dog attempted to exert himself, the temperature commenced to rise, and in six minutes stood at 39° C., and in 19 minutes more, (25 minutes after the cessation of the inhalation), the temperature of the rectum was 39°.4 C., and remained stationary at this point until the dog completely recovered his strength.

It is worthy of note, that in the preceding experiment, Sulphuric Ether depressed the animal temperature; and hence this agent may prove of value in the treatment of those cases of Traumatic Tetanus in which there is a marked elevation of temperature.

Experiment 202: Illustrating the Effects of Sulphuric Ether, when injected into the Blood.

Augusta, Ga., January 28th, 1861. Injected into the jugular vein of a young, active, fem goat, six fluiddrachms of Sulphuric Ether. In a few moments after the injection of the Ether, the goat struggled violently, and bleated, as if in great distress; these struggles continued for three minutes, gradually becoming more feeble, until at the end of this time, profound coma supervened.

Dilatation of the pupils was established before the supervention of coma. Death took place in ten minutes after the transfusion of the Sulphuric Ether.

Effects on the Temperature.—Temperature of atmosphere, 46° F.; temperature of rectum of goat, 39°.5 C.

The temperature of the rectum remained stationary during the struggles of the goat, and after the establishment of coma, slowly descended, and at the moment that the heart ceased to pulsate, and the respiration ceased, it was 39°.45 C., the loss being 0°.05 C.

After death, the temperature steadily but slowly descended,—in half an hour the thermometer in the rectum indicated 39° C., showing the loss of 0°.45 C. in 30 minutes; 75 minutes after death, temperature of rectum 38° C. The temperature of the body now began to descend more rapidly, and in 25 minutes after the last observation it was 37° C. At this time, rigor mortis was advancing, but not fully established; 35 minutes after this observation (135 minutes after death), temperature of rectum 35°.6 C.; rigor mortis progressing, but not fully established. 135 minutes after this observation, and 270 minutes after death, temperature of rectum 31°.25 C.

Effects of the injection of Ether into the Blood.—The respiration became labored; the action of the heart was disturbed; it beat rapidly but feebly; these symptoms were simultaneous at least, if not anterior to the dilatation of the pupils and the shivering of the muscles.

Autopsy 4½ *hours after death.*—Blood-vessels of dura-mater and pia-mater of brain filled with blood. Blood-vessels of brain and the prolongations of the pia-mater into the ventricles of the brain greatly congested with blood. Blood in the veins of the brain presented a cherry red, rather than a dark venous hue. The ventricles of the brain, as well as its substance, emitted strong odors of Sulphuric Ether. Spinal cord not specially congested.

Mucus surface of trachea and bronchial tubes normal in appearance. The lungs presented a purplish red color and mottled appearance, and were more dense and congested with blood than is usual in death from mechanical causes. The fact that the blood-vessels of the lungs were congested with blood, was demonstrated, not merely by the color, but also by the fact that they collapsed only partially when the thorax was opened. The lungs exhaled strong odors of Ether. Muscular structures of heart normal in appearance. Firm, dark, almost black coagula were found in all the cavities of the heart. The largest coagulum, which was about the size of a pigeon's egg, in its largest portion, was found in the right auricle, and extended through the auriculaoventricular opening into the right ventricle, and also sent branches into the vena cava and pulmonary artery. A small, flattened, dark purple coagulum was also found in the aorta. These coagula all exhaled Ether. Stomach, liver, spleen, kidneys and intestines not at all congested, and perfectly normal in appearance.

There was no marked or unusual accumulation of blood in the large venous trunks. In these respects, as well as in several others, the effects of Ether were far different from those of Prussic Acid. In poisoning by this acid, the large veins are, as far as my experience extends, loaded with dark, almost black, uncoagulated blood.

The blood corpuscles of this goat, killed with Sulphuric Ether, presented, in many cases, marked alterations; they were shrivelled in some cases, and in others stellate. Ether exhaled from the blood in all parts, and from all the organs and tissues. The color of the muscles was natural, and of a bright red, and pink, and purplish red after exposure to the atmosphere.

It is worthy of note that, in like manner, the direct injection of Sulphuric Ether into the blood caused a descent of the animal temperature.

The marked powers of Ether and Chloroform as solvents of fats, without doubt, are active in the production of the peculiar phenomena induced by their introduction into the circulation and distribution to the nervous elements. As the cerebro-spinal and sympathetic nervous systems are largely composed of fats, and of a peculiar phosphorized fat, it is possible that a portion of the peculiar phenomena resulting from the action of Chloroform and Ether may be due to the direct solution or disturbance of the physical constitution and chemical relations of the fats, and especially of the phosphorized fat of the ganglionic cells and commissures. As in the case of Chloroform, so also in the action of Sulphuric Ether, it is far more potent when employed by inhalation. Half an ounce of Ether, or even less, inhaled in the form of vapor, is capable of producing a more powerful effect on the nervous system than one or two ounces taken into the stomach. The difference appears to be due to the greater absorbing surface exposed by the lungs.

As far as my experience extends, no better combination for internal administration has been proposed than that employed in the first case of Traumatic Tetanus, viz: equal parts by measure of Chloroform, Ether and Tincture of Opium. Of this mixture, from 10 to 100 drops may be administered in simple syrup, in orgeat syrup, or in emulsion with yolk of egg, or in brandy or milk, or in any form of alcoholic stimulants, at regular intervals, according to the effects, and the nature and urgency of the symptoms.

CHLORAL HYDRATE. We have recorded a number of interesting observations and cases in the historical notes upon the treatment of tetanus and in the table, showing the value of Chloral as a producer of sleep, and as a valuable agent in the treatment of Traumatic Tetanus and other diseases of the nervous system. Chloral Hydrate was employed in cases 401, 403, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 422, 478, 479, 480, alone and in combination with Bromide of Potassium, and Extract of Calabar Bean. Of these 21 cases, only two terminated fatally, giving a mortality of only 9.52 per cent., or one death 10.5 cases.

In the administration of Chloral, we are, in effect, employing Chloroform in a pleasant and efficient form; for M. Persoune has demonstrated by actual experiment, that Hydrate of Chloral does not pass through the human organism without undergoing a transformation, but that on reaching the blood it is separated into formic acid and Chloroform, which latter substance is subsequently converted into Chloride of Sodium and formiate of Soda, the products of its elimination. As a hypnotic, it appears to be inferior to Opium alone; whilst at the same time it is superior to Opium and almost every other drug, that in its sleep-producing action, there are no attendant symptoms of cerebral oppression; the sleep, though often prolonged, is light and refreshing, and no unpleasant after symptoms are experienced.

These remarks apply only, however, when it is used in moderate quantities, for both unpleasant and fatal symptoms have been produced by large doses; and in every case we should administer it cautiously at first, beginning with not larger doses than from 20 to 60 grains, separated at intervals varying with its effects. As a remedy for pain, it should be borne in mind that it is far less certain and efficient than Opium and its preparations. This fact I have carefully verified by experiments upon myself.

Chloral Hydrate may, in some cases, be combined with Bromide of Potassium with benefit. The following formula will be found useful in the treatment of Traumatic Tetanus and cerebro-spinal meningitis: ℞ Chloral Hydrate, ʒiv; Potassii Bromidi, ℥i; Syrupi Simplicis, f℥vi; mix; tablespoonful every one, two, three or four hours, according to the nature and intensity of the symptoms.

Croton Chloral Hydrate, as far as my knowledge extends, has not yet been employed in the treatment of tetanus, but its physiological effects would indicate that it may prove equally as effective as Chloral Hydrate. The relatively small dose of the Croton Chloral Hydrate may also be regarded as favorable to its use in tetanus.

Chloral is not suited to sub-cutaneous injection, for M. Laborde has shown that when it is injected, even in weak doses, in animals such as rabbits or Guinea-pigs, it causes local irritation, gangrene, and more or less purulent infiltration.

Alcohol, in large doses, (cases 109, 110, 111, 283, 472), produced effects in some respects similar to those which characterize the action of Chloroform, Hydrate of Chloral and Sulphuric Ether, viz: relaxation of the muscles and profound sleep. In these 5 cases, 4 recovered and one terminated fatally, giving a mortality of 20 per cent., or one death in 5 cases. There appears to be no question as to the value of alcoholic stimulants in the treatment of this disease, as has been shown by the observations of Currie and others. There appears to be, in the present state of our knowledge of the therapeutics of Traumatic Tetanus, nothing to contra-indicate the use of Alcohol in conjunction with such remedies as Opium, Chloroform, Sulphuric Ether and Chloral Hydrate. Alcohol, in large doses, reduces the animal temperature, arrests to a certain extent the changes of the tissues, diminishes the motor and reflex powers of the Spinal cord, promotes sleep, and acts as a nutriment.

Opium.—No remedy has been employed more frequently than Opium in the treatment of Traumatic Tetanus. An examination of the table will show, that in one form or another, and in various modes, it was employed in a majority of cases, even when other potent agents were administered at the same time. Owing to the frequent combination with opium, of one or more powerful agents and remedial measures, as Calomel, Tartar Emetic, Tobacco, Calabar Bean, Indian Hemp, Quinine, Chloroform, Amputation, Venesection, Blisters to the entire length of the spine, etc., it is impossible to demonstrate, by actual statistics, the value of this drug. And it is a question whether the immense doses in which it has been so often administered, may not have been absolutely injurious; and whether much better results would have been obtained by a more moderate use of this powerful and valuable agent. It would appear from the insensibility of many tetanic patients to the action of Opium in immense doses, that a peculiar condition must characterize the cerebral nervous elements, as well as those of the spinal axis; for in those cases in which it controls the muscular spasms, its narcotic effects are invariably produced at the same time. Such facts appear to support strongly the view which we have advocated, of the local origin of Traumatic Tetanus and the progressive transmission of the irritation to the central ganglionic masses of the cerebro-spinal nervous system, and at the same time to militate against the theory that tetanus is due to some poison in the blood analogous to that of Hydrophobia. It has been said by Dr. W. Hanna Thomson, of New York, (Am. Med. Times, Feb. 2d and 9th, 1861), that there is but little doubt that, were we not sure that Hydrophobia was the result of a poisoned wound, we would, by the irritative theory of tetanus, be inevitably led to ascribe the symptoms of rabies also to this mysterious but convenient irritation, but the one preceding fact of a virus introduced does away with all difficulty towards seeing in the strange nervous symptoms, not an irritation merely, but the action of a blood poison. The well known experiments of Magendie and Breschet prove that Hydrophobia can be as certainly communicated by injection of the blood of the rabid animal as by the inoculation of saliva, and Hertwig, (Hufelands Journal, 1828), proved, by his many excellent experiments, that not only portions of the salivary glands laid on the wounded surface, but the blood itself, venous and arterial, are capable of communicating the infection. Dr. Thomson still further endeavors to establish the hæmatic pathology of tetanus by the well known fact, that we can produce something very much like tetanus, at will, by charging the blood with a ready made poison, as Strychnine.

Whilst admitting that there is an analogy, and a very striking analogy, between Hydrophobia, Strychnine poisoning and tetanus; at the same time it must be conceded, that a mere analogy and similarity of prominent symptoms do not necessarily establish an identity of origin. Such a mode of reasoning is plausible, but not conclusive. We can only account for the arrest of tetanus in certain stages, by the application of the actual cautery to the injured nerve and surrounding parts, by amputation and by section of the injured nerve, on the theory that the disease originates in the injured nerve or nerves, and is propagated along the nervous tracts centrifugally to the spinal axis. And the accuracy of this view has been sustained by the pathological changes which have been frequently witnessed in the injured nerves, and in the spinal cord itself. If the disease be manifestly due to the existence of a Materies Morbi, existing in the blood, and generated in the diseased part, or in the system, under certain circumstances, the duty of the physician should be to seek some remedy which would displace and expel the poison of tetanus from the blood, and he could best explain the curative effects of such an agent as Opium, by its power of neutralizing or eliminating the poison.

As no such poison has ever been shown to exist in the blood of the tetanic patient, and the phenomena of the disease, as well as the characteristic alterations are best explained without any such hypothesis, the physician acts most rationally and philosophically in the employment of those remedies and measures which are capable of arresting, controlling and subduing the state of increased and exalted activity of the nervous elements primarily involved.

While on the one hand, Opium is valuable in the treatment of Traumatic Tetanus, by its power of diminishing muscular force, and the susceptibility of the cerebro-spinal system to external impressions, and of rendering the nervous system insensible to pain, and of producing quiet repose and profound sleep; on the other hand, it may act injuriously when given in large and repeated doses, by deranging the digestion and by diminishing the biliary and intestinal secretions, and thus aggravating the constipation characteristic of Traumatic Tetanus, and it may also induce a state of functional derangement and irritation of the cord, analogous to that characteristic of Tetanus. In order to avoid certain of these effects, Morphia, by sub-cutaneous injection, may be advantageously substituted for the internal administration of Opium and its preparations.

Tobacco.—The delight and satisfaction with which Tobacco was hailed as a luxury in Europe after its introduction from America, about the year 1559, was only surpassed by the reputation which it speedily acquired as a medicine. Its value was loudly proclaimed as a panacea; it was boldly asserted that the discovery of this herb alone, had placed the moderns above the ancients; and not only did physicians, like Magnenus, give a long list of the diseases which it cured, but poets lavished upon it their choicest epithets. Tobacco obtained the greatest fame as an external application to wounds; to ulcers and diseases to the skin. Used externally, it was the great remedy resorted to by the nations of the Spanish Main for Tetanus, and in the Transactions of the Medico-Chirurgical Society of Edinburg, two cases of *trismus* are narrated by Dr. Anderson of Trinidad, in which good effects resulted from its use in the form of baths; four ounces of the dried plant were boiled for an hour, in eight gallons of water, and then added to impregnate the water of a tepid bath.

In the "*Trial of Tobacco*," written by Edmund Gardiner, about 1648, it is said that "the suffumigation of tobacco being taken, is a good medicine for starkness or stiffness of neck called tetanus, and for any pains or aches in the body, proceeding of the cause that tetanus doth." Magnenus, Neander and others, held the same opinion, but it was only of late years that it has been resorted to in the treatment of Tetanus. In this disease it has been employed as an injection and highly extolled. Mr. Duncan, of Grenada, published a successful case, thus treated, which was detailed in the 42d number of the Edinburgh Medical and Surgical Journal, which excited considerable interest at the time. In 1807, Dr. Huggan suggested Tobacco as a remedy in Hydrophobia, and subsequently Dr. Clutterbuck, and Dr. Sigmond, actually employed it in the treatment of this disease, with the effect of producing temporary alleviation of the spasms. Lancet, May 13th, 1837, p. 253.

In the table we have recorded a number of cases (125, 126, 132, 146, 153, 157, 166, 167, 169, 170, 173, 182, 219, 220, 225, 226, 234, 235, 240, 241, 276, 278, 289,) in which tobacco was employed alone, or in combination. In 23 cases, in which this agent was thus used, 12 recovered and 11 died, giving a mortality of 47.82 per cent, or 1 death in 2.09 cases.

According to Mr. Travers, the infusion of tobacco, injected per anum, beginning with half a drachm, of the dried leaf to a pint, and increasing the strength to double, if indicated, may be employed with signal effect in calming the spasm of tetanus. It may be used twice or thrice daily, with perfect safety, in the onset of the disease. It produces nausea, perspiration and sleep, often of hours continuance; but above all it diminishes the force and frequency, if it does not arrest the morbid action, and gradually restores the pliancy of the fixed and board-like muscles. To counteract its depressing effect, and indeed to support the patient under the disease, independent of all medicinal remedies, Mr. Travers gave strong animal broths or jellies, and alcohol in the form of brandy or wine, every hour or two; and this he held to be a not less important indication of treatment, for patients have been lost in tetanus, from want of proper nourishment and cordials, oftener than from want of proper medicines.

The testimony of Mr. Curling as to the value of Tobacco in the treatment of Tetanus, is equally clear and decided. Of nineteen cases, in the Table of Mr. Curling, in which

Tobacco was employed, *nine* recovered. Mr Curling concludes his observations upon this agent, in the following manner:

> "I conceive that more has now been advanced in proof of the efficacy of tobacco, than can be adduced in favor of any remedy yet resorted to. I have not, indeed, succeeded in finding a single case, in which, being fully and fairly tried, before the powers of the constitution had given way, it has been known to fail. Many more cases have been cured by the use of opium, and for the obvious reason, that a far larger number have been treated with it. Tobacco is a more certain and potent sedative than opium, the latter being a remedy that never can be relied on, having failed far oftener than it has cured. Many appear to dread so powerful an agent, as a remedy more dangerous than the disease; but without resorting to so weak an argument, 'Melius anceps remedium, quam nullum,' it may be justly alleged that only the rash abuse, and not the judicious exhibition of tobacco, can afford ground for apprehension. I would not say that tobacco is a remedy, which, even resorted to at an early period, and employed with judgment, will always avail; for I believe that in its worst forms, Tetanus is a disease of too destructive a nature to be arrested by any treatment whatever; but I hold it to be the best remedy that we at present possess, and one which will generally be found capable of diminishing the severity of the acute disease, and often of subduing it altogether.
>
> "The doses should be regulated by the age, habits and constitution of the patient, who, during its use, must be supported by a nourishing diet, tonics, wines and other stimulants. The Carbonate of Ammonia, in particular, is well adapted to counteract the extreme prostration sometimes induced. At the commencement, a scruple of the tobacco leaf infused in eight ounces of water, will be enough for an injection, which must afterwards be increased in strength, in proportion to its effects. A stronger infusion will be necessary for those who are accustomed to the use of this plant as a luxury. Unless in Chronic Tetanus, baths impregnated with it are not only insufficient, but objectionable."—Treatise on Tetanus, p. 91.

Mr. Haughton recommends the use of Nicotine instead of the infusion of Tobacco, on the ground that in the latter the alkaloid is combined with two or more vegetable oils, the operation of which on the nervous system is unknown. He relates, (Dublin Quart. Jour., Vol. 34, p. 172), two cases of traumatic, and one of idiopathic tetanus thus treated. In the first case, which proved fatal, the patient was nearly moribund when the medicine was given; it had, however, the effect of causing the immediate relaxation of the muscles of expression, of respiration and of deglutition, cessation of delirium, and feeling of relief from agonizing pain, and a lowering of the pulse from 130 to 88. This case received 3 doses of one minim of Nicotine at intervals of two hours, The second was the case of idiopathic tetanus; it recovered. The dose was from half to two-thirds of a drop, repeated several times a day, so that in 11 days 44 drops were taken. The effects noticed in this case were immediate relaxation of the muscles of the abdomen, back and diaphragm; cessation of delirium; a slight tendency to increased circulation, the pulse being quickened 10 beats per minute; profuse sweating, which exhaled an intolerable odor of snuff, not of tobacco; a tendency to deep sleep. The adductor muscles were not as easily brought to desist from their spasms as the others, even when the hamstring muscles gave way, the adductors refused. The third case recovered; the Nicotine was given in doses of 1, 2 and 2½ drops, according to the urgency of the tetanic spasms. After the administration of the dose, in 3 minutes the spasm was gone, and the muscles relaxed and profuse sweating accompanied by a smell of snuff, set in. During the four days of treatment with this medicine, the patient received by the mouth and rectum, altogether, 54 drops, equal to 32½ grains.

Mr. Tyrrell, as quoted by C. Handfield Joues, in his "Studies on Functional Nervous Disorders," p. 253, records two well marked cases of Traumatic Tetanus, which he treated by the local application of Tobacco. (Med. Times and Gaz., 1864, Sept. 24th). Both terminated successfully. Mr. Tyrrell argues that as Tobacco is of service when given internally, it should be more so in eccentric Tetanus, if applied locally, by paralyzing the nerves of the effected parts from which the irritation proceeds, and thu removing the cause of the spasms. In the idiopathic form, Mr. Tyrrell proposes to remove the cuticle of the skin by a blister, and to apply a strong solution of Tobacco to the denuded surface, and thinks that in this way, the cord would more quickly be

nder the influence of the remedy, and with less vital depression than when
internally.

of the cases reported, a strong infusion of Cavendish Tobacco was applied to
surface, 12 inches square at the back of the neck, as well as to the nose
been injured, and the patient was supported by clysters of Brandy, Ether,
nd strong Beef Tea, given every four hours. The treatment was begun on
on the 24th, he was able to swallow, on the 26th, the neck which had been
quite pliant. Delirium then supervened, but yielded to Quinine and Opium,
e to six days, the disease was at an end. Mr. Junior, as quoted by the same
testifies strongly to the good effect of Mr. Tyrrell's plan in a very interesting
h he has published in the Ed. Med. Jour., Feb. 1867. He used at first a
f Cavendish Tobacco of the strength of ℥iv ad Oj; at a late date the strength
ed. The case was one of great severity, and the sufferings were extreme.
wo or three hours after the application of the infusion to the wound, which
the improvement was most marked. All the rigid muscles became to a con-
extent relaxed, the mouth could be opened about half an inch, the paroxysms
severe and frequent, and a good deal of sleep was obtained. There were
iculties to be overcome, before the wound was healed, and recovery complete,
ase terminated favorably in about two months. Mr. Junior says, there can be
that the recovery of the patient was due to the Tobacco stupes.

letting, Calomel and Antimony, are doubtful remedies in the treatment of
e Tetanus. The disease has been known to sapervene upon wounds, which
attended with the most profuse hæmorrhages, and it has pursued its course
d by the most energetic employment of blood-letting. If Traumatic Tetanus
inflammatory disease in its inception, and if under all circumstances, it is the
he physician to preserve as far as possible the integrity of the blood, and the
trition of the body, Venesection should be employed with caution, and the
refully watched and recorded. Mr. Curling, Dr. Sandwith and others, have
cases which were benefitted by free venesection, and the remedy appears to be
applicable to idiopathic tetanus. It is difficult however to form a just estimate
easure, as it appears to have been almost always used in conjunction with other
agents, as Opium, Tobacco, Tartar Emetic and Mercury.

d its purgative effects, and its power to regulate to a certain extent the secre-
he intestinal canal, and its associated organs, Mercury appears to be of no value
eatment of Traumatic Tetanus, and the weight of testimony is against its
ent in such a manner as to affect the general system.

y-three cases reported by Mr. Curling, in which Mercury was employed, thirty-
d fatal. Of the twenty-two cases which recovered, in one case it is mentioned
ugh salivation was produced, the symptoms continued to increase, until the
of Opium was augmented; in another case, Mercury was not resorted to until
e had been established seventeen days; and in still another case, the patient
oving before ptyalism was produced; in twenty of these cases of recovery,
as combined with the mercury; and of the two treated without it, in one
injections were employed; six of these cases also were females. In eleven of
in which neither Opium nor Tobacco was resorted to, Mercury being given
employed in conjunction with some trivial remedy, as the warm bath, or blis-
ere fatal except one.

cases of Tetanus, consequent upon severe injuries, recorded by Mr. Howship,
which Mercury was freely exhibited, two only recovered, and in both of them
en in conjunction with Opium.

Larrey found that Mercurial friction rather aggravated the symptoms in the
hich it was tried in Egypt. Sir James McGregor, in numerous trials of Mer-
remedy, found it quite inert; and he notices the case of a man who was seized
nus, whilst strongly under Mercurial influence, for the cure of a cutaneous

Mr. Mosely mentions that many people have been attacked in the West Indies while under a course of Mercury, and expresses the opinion that it has killed more than it has cured. (Treatise on Tropical Diseases, p. 478.)

Dr. Wells has related three instances of the occurrence of Tetanus, during Salivation from the use of Mercury.

Sir Anthony Carlisle, informed Mr. Curling of two instances in which the disease was developed in the course of salivation for another complaint. Dr. Thomas of Jamaica, witnessed several cases which proved fatal when the full effect of Mercury had been produced; he observes that he has seen patients expire with a stream of saliva flowing from their mouths. (Ed. Med. and Surg. Jour., Vol. xviii, p. 39.)

Mr. Maxwell has also recorded a case of Tetanus in a negro, which proved fatal after the production of ptyalism.

Mr. Curling witnessed two traumatic cases, in which some ptyalism was produced without being followed by the slightest mitigation of symptoms. In both of them extreme suffering was occasioned by the increased secretion of saliva. The mouth being closed by the spasmodic action of the orbicularis oris, to prevent the distressing contraction of the throat, and the suffocating paroxysms consequent upon attempting to swallow the saliva, the patients were compelled to keep their lips constantly apart with their fingers. *Treatise on Tetanus, pp. 74, 75.*

The effects of *Antimony*, when introduced directly into the blood, are shown in a striking manner in case 263, of the table; although its characteristic action was manifested immediately, it exerted no influence upon the disease, the tetanic spasms continuing with unabated severity. The majority of the cases, in which it has been employed terminated fatally. Its power of diminishing and relaxing the muscular force, appears to be dependent upon the nausea, vomiting, purging, and perspiration which it induces, and also upon its direct depressing effects upon the action of the heart. Antimony is, when used freely, uncertain and uncontrollable in its action upon the nervous system, and is liable when employed in sufficient doses in Traumatic Tetanus to induce fatal prostration. In most of the cases in which it has acted beneficially, it has been combined with Opium and Morphine, and it is but fair to attribute the good results chiefly to the latter remedies.

Quinine has been employed with a fair degree of success, more especially by American physicians, (see cases 347, 349, 351, 357, 384.) and of these 5 cases, only one proved fatal. Other remedies, however, were employed in conjunction with Quinine. Further investigations as to the effects and value of Quinine in the treatment of Tetanus are needed.

Woorara. The experiments of Sir Benjamin Brodie, in 1811, demonstrating the action of Woorara upon the motor nerves, the application of the results of Professor Sewell, at the Vetinary College, and the subsequent experiments of Mr. Morgan and of Dr. Harley, not only anticipated the results obtained by the continental physiologists, but also led finally to the actual trial of this powerful agent in Traumatic Tetanus. The application of Woorara to the treatment of this disease was based, not only upon a knowledge of its physiological action, but also upon its antagonistic effects to the artificial Tetanus of Strychnine, and upon the results of its use in the idiopathic tetanus of the horse and ass. The superior value of Woorara to other narcotics, appears to consist in its peculiar power of paralyzing the motor and not the sensory nerves, and it appears that it might be so administered, as to destroy entirely the power of voluntary motion without impairing consciousness. In administering Woorara to animals laboring under Tetanus induced by Strychnine, Dr. Harley gave sufficient to paralyze all the muscles except those of respiration. In this way he was able to allay the tetanic spasms without destroying the intelligence, or arresting the performance of the organic functions. by continuing the thus moderated action of Woorara, until the kidneys had time to eliminate the Strychnine from the system he had been able to save the life of the animal. According to Dr. Harley, the theory of its action in tetanus is much the same. is to say, you try to keep the spasms from killing the patient by their violence, until morbid state calling them into play has exhausted itself. According to this observer, the chances of curing by Woorara, a patient laboing under Strychnine poisoning, are naturally much greater than those of curing a case of Traumatic Tetanus, where the morbific matter may go on increasing until its effects were more than sufficient to counteract the influence of Woorara. This explanation of the failure of Woorara to cure a certain, and that a very large proportion of cases of tetanus, does not appear to be satisfactory, because it is based upon the supposition that a morbific material is the cause of Traumatic Tetanus, the violence and nature of the symptoms depending upon the amount of the poisonous matter which acts antagonistically to such remedies as Woorara. If this morbific matter really exists, it would seem to be entirely possible for such an able physiologist as Dr. Harley, to demonstrate its existence by noting the effects produced upon animals by inoculating the secretions of the wound, or of the blood or juice of muscles, or of the urine and other excretions of the tetanic patient. The failure of Woorara in the treatment of Traumatic Tetanus, may more rationally be referred to its variable strength, no two specimens producing effects of equal degree to its uncertainty when administered by the mouth, to its violent effects when inoculated, and more especially to the fact, that in order to overcome tetanus it is necessary to give an *adequate* dose, and an adequate dose in severe cases would be such as absolutely to arrest respiration.

Without the greatest precaution, the remedy will prove more dangerous than the disease. Cases of tetanus have been treated by Woorara, on the continent by Vella, Manoe, Cassaignac and others, and in England by T. Spencer Wells and others. In eight cases of tetanus treated with Woorara on the continent and in England, five proved fatal, and three recovered; thus giving a mortality of 62.5 per cent.; and it should also be stated, that the three cases which recovered under the use of this powerful agent were of the chronic variety, whilst the five which proved fatal were of the acute variety.

It may well be questioned, if in view of such mortality, which appears to have been influenced in a doubtful manner by the drug, whether it would be subserving the best interests of those afflicted with tetanus, to rely upon so powerful and uncertain an agent, instead of employing those which have yielded far better results.

An Italian Surgeon appears to have been the first to use Woorara in the treatment of tetanus; he employed it in three instances, applying the poison in solution to the wounded part, and where no wound was present to a raw surface artificially produced by blisters. In two of his cases the tetanus was acute and traumatic, but both died; in the third case the disease was chronic, and recovery ensued. If these be added to the preceding eight cases, we have four recoveries and seven deaths, in 11 cases treated by Woorara; the four cases which recovered were chronic, and would most probably have recovered without this drug, and the seven which terminated fatally were all acute.

According to H. Demme, of 22 cases of Traumatic Tetanus treated by Woorara, (Curare,) up to the year 1863, 8 recovered; the mortality being 64.6 per cent. Busch employed this agent in a certain proportion of the cases occurring after the battle of Koniggratz; the disease did not appear until the second week after the engagement;—before Curare could be procured 9 patients died, a tenth was saved by the hypodermic injection of one-fourth of a grain of Morphia, every two hours; of the remaining 11 cases which were treated with Curare five died, one, however, of pyæmia; improvement took place in all; the duration of the successful cases was from 7 days to 4 weeks. He ascribed its good effects to its preventing the cramp-like muscular contractions, which react injuriously on the spinal cord, intensifying its reflex excitability, and to the avoidance of the excessive increase of temperature resulting from the powerful action of the muscles. He prefers administering the remedy by sub-cutaneous injection, as its operation is uncertain by the mouth. The dose varies according to the purity of the preparation from grain $\frac{1}{50}$ to grain $\frac{3}{16}$.

Woorara was employed in cases 315, 316, 326, 394, 474, all of which, except one proved fatal, and in case 394, the fatal issue was directly referable to the action of the poison. Dr. Wm. A. Hammond and S. Wier Mitchell, in their important experiments on the Woorali poison, (Am. Jour. Med. Sci., July, 1859, p. 13), found that in a few minutes after the introduction of the poison through a wound, paralytic phenomena soon became obvious, and the animal died without preliminary spasm or convulsion, but the heart, instead of continuing to act after apparent death, had entirely ceased to beat, so that it could not be excited by galvanism. They inferred that the action of the poison is directly and primarily on the heart, possibly on the ganglia contained in its tissue. The capillary circulation was always arrested a minute or two before the heart's action, which they ascribed to paralysis of the sympathetic.

Woorara has not, therefore, fulfilled the expectations of the physiologist and physician, and has not increased our means of arresting or curing Traumatic Tetanus.

By a reference to the table, it will be seen that more favorable results were obtained with Extract of Indian Hemp, (Cannabis Indica), and Calabar Bean.

Extract of Indian Hemp, (*Cannabis Indica*), was employed in cases 269, 270, 277, 278, 279, 280, 282, 313, 319, 327, 346, 360, 361, 379, 386, 431, 473, 475, 476, 477; and of these 20 cases, 12 were cured and 8 terminated fatally, giving a mortality of 40 per cent., or one death in 2.5 cases. Mr. O'Brian used the resin of Indian Hemp in seven cases, with the effect of producing almost immediate relaxation of the muscles and interruption of the convulsive tendency. More than one half, or four of Mr. O'Brian's cases recovered. The late Dr. Baine used the remedy in three cases, two of which recovered. Dr. Lewis, (Edin. Med. Jour., Aug., 1859), reports a case of Traumatic Tetanus in a lad, æt. 13, which terminated favorably under 4 grains of Indian Hemp every three hours, the first being preceded by a full, free bleeding. No toxic effects were produced, notwithstanding that the Extract of Cannabis Indica was continued at the same rate for three days. Skues treated a girl æt. 9, suffering from Traumatic Tetanus, with Indian Hemp, nourishing soups and wine; she took from 4 to 18 grains daily of the extract, and was kept in a continual state of narcotism; the symptoms gradually declined in severity, and the patient was convalescent on the 13th day. Dr. Famage treated two cases of Idiopathic Tetanus by Tincture of Cannabis Indica, thirty minims every two hours, one of which terminated fatally and the other recovered.

Dr. Charles D. Allen, of Glenarm, has recently reported a case of Traumatic Tetanus (British Med. Jour., April 4th, 1874, p. 450), which occurred in a lad æt. 11, whose left hand had been crushed and lacerated by cogged-wheels. Tetanus appeared on the 18th day after the injury and the amputation of the second, third and fourth fingers. The spasms were severe, the pulse rapid—140 per minute, the respiration 40, and the temperature 103° F. Under the persistent use of Tincture of Cannabis Indica, combined with solution of Muriate of Morphia, (one drachm each every two hours), the violence of the symptoms gradually abated, and convalescence was established in two weeks.

Extract of Calabar Bean was employed in the treatment of cases 398, 399, 402, 404, 414, 415, 421, 422, 423, 471; and of these 10 cases, 8 recovered and 2 terminated fatally. In some of these cases, as in 414, 415 and 421, this remedy was employed in conjunction with the Hydrate of Chloral. The preceding cases yield a mortality of 20 per cent., or one death in 5 cases.

In case 398, reported by Mr. E. Watson, (Pratcitioner, 1870, p. 207), 2 grains of the alcoholic extract were administered at one dose, and at varying intervals, and 123 grains were given during 46 days.

In case 399, reported by Dr. W. Harning, (Lancet, 1869, p. 834), the Extract of Calabar Bean was administered by sub-cutaneous injection, In 30 days, about 11 drachms of the Extract of Calabar Bean were injected, generally in quantities of a half grain. The antagonistic effect of the remedy upon the well marked trismus and opisthotonos was immediate and well marked. The arched back, painfully tense abdomen, quivering limbs, and anxious countenance, were generally relieved in from five to ten minutes after each injection, by comfortable decubitus, a feeling of drowsy ease, and during the night by short snatches of sleep. In case 402, the extract of

Calabar Bean was administered, both by the mouth and by injection. The extract was given every two hours alternately, by the skin and mouth, so that in every four hours one grain and a half were administered, viz: one grain by the mouth and half a grain by the skin. During the attack, the total amount of extract administered was 40⅞ grains by the skin, and 49½ grains by the mouth, making, in all, 90⅜ grains given in 10 days. The reporter of this case, Dr. A. Boutflower, (Manchester Med. and Surg. Reports, 1870, p. 52), was led to use this remedy from the effect which it possesses of paralyzing the spinal cord, without at the same time depressing the action of the heart to any great degree.

In case 471, reported by Mr. Ashdown, (Brit. Med. Jour., 1868, March 21st): Calabar Bean was administered both internally and by sub-cutaneous injection. The patient was bled to a pint on the 2d day after the supervention of Lock-Jaw; on the following day he began to take ⅛ of a grain of the extract of Calabar Bean in one fluiddrachm of water every half hour, and was supported with strong Beef Tea, Milk, and Port Wine 8 oz., and Brandy 4 oz. On the next day, the dose of Calabar Bean, and the stimulants and nutritive fluids were doubled, as the patient was much worse, and the violent paroxysms coming on every four minutes. On the next day the state was the same, and the Calabar Bean was ordered to be administered sub-cutaneously by injection, gr. ¼ of the extract dissolved in 18 minims of water, being thus given every two hours. The effect of the first injection was very marked; in about five minutes, the legs which had been previously rigid and immovable, became flaccid and freely movable by the patient, the abdominal muscles became less tense, and the aching of the spine disappeared.

The pupils also contracted, and the pulse sank to 82. The effects lasted two or three hours, and all the symptoms then reappeared. The injections were again continued every two hours with similar effects. The pupils were much contracted, and the patient at times was very delirious. As the injections occasioned much pain and inflammation in the areolar tissue and the solution was found to be acid, a few drops of Liquor Potassæ were added to it. This corrected the above-mentioned ill effects. The injections were continued for nine days, when at the end of this time, the severity of the disease was evidently subsiding, and they were then replaced by suppositories of the same extract, containing grain, ¼ to be applied every two hours. Morphia was given with benefit every night. He took 12 eggs and 2 bottles of sherry in twenty-four hours. In one month the malady was at an end.

Dr. John Cunningham, of Campbeltown, (Brit. Med. Jour., April 4th, 1874, p. 450), has reported a case of Tetanus, (Traumatic) occurring in a boy, aged 7, from laceration of the foot, which was cured by Calabar Bean. Dr. Cunningham administered the Extract of Calabar Bean in solution, in amounts ranging from $\frac{1}{24}$th to ⅛th of a grain every hour.

Dr. Fraser has shown by valuable and elaborate investigations, that the active principle of Calabar Bean quickly enters the blood, and causes muscular motion to cease, and renders the entire muscular system limp and flaccid. It produces general paralysis, and destroys all reflex action of the cord. Respiration under the influence of the poison, grows gradually slower and slower, and at last ceases. Consciousness appears to be preserved throughout. As muscular contraction can be easily and abundantly excited by direct irritation of the muscles, after the motor nerves have quite lost their power to conduct impressions, it is evident that the poison has no influence on the voluntary muscles; paralysis is not produced by any changes in the brain, for conciousness is intact when paralysis is marked and progressing, and if the brain be removed and the animal poisoned, the paralysis ensues as usual; paralysis is not produced by the action of the poison on the spinal nerves, for long after general paralysis is produced, and even after death, they conduct the motor impressions to the muscles; finally the paralysis depends alone upon the spinal cord, and is due to changes affected in this organ by the Calabar Bean. The reflex functions of the cord are destroyed by Calabar Bean, long before the spinal nerves lose their power to conduct.

From its physiological action on the cord, Dr. Fraser recommends the Calabar (Ordeal) Bean, as an antidote to Strychnia, and he shows that it is superior to Curare, as this last paralyzes only the motor nerves, while the Calabar Bean first paralyzes the cord, and after some time, the motor nerves also.

Dr. Fraser has collected twelve cases of tetanus treated by Calabar Bean. Of these, eleven only are useful in estimating the value of this drug, as the twelfth case was not treated with Calabar Bean, until near its close; and only one dose was given before the patient died. Of the eleven remaining cases nine recovered, and of the two fatal cases, in one the remedy was given in insufficient quantities. This drug should, according to Dr. Fraser, be given at the very beginning of the attack, for when muscles contract, they beget a substance which excites muscular contractions, and at the beginning of tetanus, only a limited part of the cord or ganglia of the brain is involved, but speedily, on the continuance of the disease, the whole of these structures are affected.

The extract of Calabar Bean should always be used in preference to the powder, as it is the most concentrated preparation, and one on whose constancy we may rely. It may be given in the form of pill, or of solution, and suspension in water (mixture), or of solution in weak spirit of Sp. Gr. 0.920 (thirty-two grains to the fluidounce). The first and last of the two forms are to be preferred, as that with water decomposes in a few days. The Extract may be administered by the mouth, anus, or sub-cutaneously, In tetanus, the method by sub-cutaneous injection should be preferred. For an adult, one grain of the extract by the stomach, or one-third of a grain by sub-cutaneous injection, will be generally sufficient to commence with: this should be repeated in two hours, when its effects will usually have passed off, and the succeeding doses may be modified according to the experience thus gained. When used by sub-cutaneous injection the dose of the extract should be carefully mixed with ten or fifteen minims of water; this mixture has always an acid reaction, which is sometimes so decided as to produce slight irritation of the cellular tissue; but this can be avoided by carefully neutralizing the mixture with a solution of Carbonate of Soda. When administration by the anus is desired, suppositories, containing two grains of the extract, may be made with Oil of Theobroma and White Wax. The remedy should be given at regular intervals in accordance with its effects.

Aconite was used in the treatment of Cases 288, 289, 318, 389, and of these four cases, three recovered and one died; a very favorable result. The physician in employing this valuable but potent agent, should remember that its success depends upon the possibility of the heart being able to tolerate a sufficient amount to overcome the excitement of the spinal centres. In Traumatic Tetanus, we have the local injury, from which irritation is conveyed to the nervous centres, including a state of hyperæsthesia or exalted polarity of these centres (the brain excluded,) derangement of nervous function, increase of irritability, and contracted and torn muscular fibre, the consequent crushing of the sensitive nerves, and obstruction of the capillary circulation of the affected parts; followed by the consequent exhaustion; death occurring by asphyxia, by spasm, or by asthenia from exhaustion, or by syncope, from sudden cessation of the heart's action. Aconite on the other hand, according to Dr. G. Smith of Hyderadad, alters the character of the local irritation, then abolishes it, the tingling being followed by numbness; it acts as a sedative of the nervous centres, (cerebrum excluded,) diminishing their polarity, and inducing a state of anæsthesia, impairing the excito-motor, vaso-motor, and voluntary systems of nerves, causing muscular weakness, paralysis of the diaphragm, suspension of spasm, paralysis of the capillaries, and general exhaustion, eventuating in death by asphyxia, from paralysis, or by syncope, from shock. As no two states of the system can resemble each other more closely, than those dependent upon Strychnine and Tetanus, and no two states of the nervous system are more thoroughly antagonistic than those induced by Tetanus and Aconite.

Belladonna, according to Brown-Séquard, diminishes the reflex activity of the spinal cord, by contracting its blood-vessels; but whether or not this be its *modus operandi*, it appears to exert a direct sedative effect upon the nerve cells. In case 281, the

Extract of Belladonna certainly exerted beneficial effects. And it appears from the observations of Mr. Hutchinson, that in Tetanus, large doses of this potent agent may be administered without the manifestation of dangerous symptoms, the enormous dose of 5 grains of the extract being suscessfully administered; and still farther that the system appears to acquire a tolerance for the remedy, which necessitates its progressive increase.

Farther observations, are necessary for the establishment of the relative value of *Atropia* and Strychnia.

The application of *ice to the spine*, after the method recommended by Dr. Todd, promises to be of some use in the treatment of this disease; we are however, without the necessary facts to show the relative value of this measure.

Owing to the almost invariable presence of obstinate constipation in tetanus, *purgatives* have been recommended and employed by almost every physician and surgeon. The weight of testimony appears to be in favor of Croton Oil, which recommends itself not only on account of the efficiency and certainty of its action, but also on account of the facility with which it may be administered, even when the jaws are firmly locked; it being only necessary to place a drop or two of the oil upon the tongue.

Assafœtida, Camphor and Musk, are of doubtful utility in the treatment of Traumatic Tetanus; and this observation applies also to the application of blisters over the region of the spine.

In conclusion, in the present state of medical knowledge, in the treatment of Traumatic Tetanus, the highest places must be assigned, and the greatest importance attached to, the following remedial agents:

Chloral Hydrate.
Calabar Bean.
Chloroform.
Sulphuric Ether.
Cannabis Indica.
Tobacco.
Bromide of Potassium.
Opium.

Important advances in the Therapeutics of Traumatic Tetanus, will be made, when in its treatment, all empirical remedies are discarded, and the attention of the entire profession is concentrated upon two or more remedies, as Chloral Hydrate, Calabar Bean and Bromide of Potassium.

OBSERVATIONS

ON

CEREBRO-SPINAL MENINGITIS;

AND MORE ESPECIALLY AS IT APPEARED AMONGST THE

SOLDIERS OF THE CONFEDERATE STATES ARMY

DURING THE

CIVIL WAR OF 1861-1865.

OBSERVATIONS ON CEREBRO-SPINAL MENINGITIS; AND MORE ESPECIALLY AS IT APPEARED AMONGST THE SOLDIERS OF THE CONFEDERATE STATES ARMY DURING THE CIVIL WAR OF 1861-1865.

CHAPTER VI.

OBSERVATIONS ON THE HISTORY OF CEREBRO-SPINAL MENINGITIS IN FORMER PERIODS.

HISTORICAL NOTES ON CEREBRO-SPINAL MENINGITIS AS IT OCCURRED IN THE ARMIES OF THE SOUTHERN CONFEDERACY DURING THE WAR OF 1861-1865.

RESULTS OF THE EXAMINATION AND CLASSIFICATION OF THE SICK AND WOUNDED, AND MORTUARY RECORDS OF THE CONFEDERATE STATES ARMY.

OBSERVATIONS OF CONFEDERATE SURGEONS ON THIS DISEASE.

REPORTS RELATING TO A VERY FATAL MALADY WHICH OCCURRED AMONG SOME OF THE TROOPS OF THE ARMY OF NORTHERN VIRGINIA, SUPPOSED TO HAVE BEEN CEREBRO-SPINAL MENINGITIS.

"REPORT OF SICK AND WOUNDED IN TEN COMPANIES, TWENTY-SECOND NORTH CAROLINA REGIMENT, STATIONED AT CAMP GREGG, NEAR FREDERICKSBURG, APRIL, 1863, BY P. GERVAIS ROBINSON, SURGEON P. A. C. S."

"REPORT OF W. D. MITCHELL, M. D., SENIOR SURGEON RHODES' BRIGADE, ARMY OF NORTHERN VIRGINIA."

"REPORT OF J. T. BANKS, M. D., SURGEON THIRTEENTH REGIMENT GEORGIA VOLUNTEERS, ARMY OF NORTHERN VIRGINIA."

"REPORT ON THE PRECEDING PAPERS BY SURGEON R. J. BRECKENRIDGE, M. D., INSPECTOR OF CAMPS AND HOSPITALS, ARMY OF NORTHERN VIRGINIA."

"EPIDEMIC OF CEREBRO-SPINAL MENINGITIS BY SURGEON G. A. MOSES, OF MOBILE, ALABAMA."

EPIDEMIC OF CEREBRO-SPINAL MENINGITIS IN NEW ORLEANS, 1872, 1873.

Lord Bacon characterized Medicine as a Science which had been more *professed* than laboured, and yet more laboured than advanced, the labour having been rather in circle than in progression. With much repetition there was but small addition. Bacon very justly complained of the discontinuance of the ancient and serious diligence of Hippocrates, which used to set down a narrative of the special cases of his patients, and how they proceeded and how they were judged by recovery or death. Therefore having the example proper in the Father of the art, there was no need to bring a foreign example of the wisdom of the lawyers, who are careful to report new cases and decisions for the direction of future judgments.

Whilst it is true that facts lie at the foundation of all true advancement of medical science, and that as a general rule, the conclusions reached by any investigation will be trust-worthy in proportion to the number of carefully observed and recorded facts; on the other hand, it must be admitted, that the relationship of the complicated phenomena of health and disease, cannot be discovered by observation alone. To the establishment of Medical Science, two things are requisite; observation of things without, and an inward examination, decomposition and analysis, and comparison of the results of observation; there must be both the exercise of the senses furnishing the primary ideas, facts and phenomena, and the exercise of the reasoning powers, determining in virtue of their constitution and relations, through the senses to the exterior world, the fixed relations or laws of the pathological phenomena.

In the investigation of the complicated chain of pathological actions, experiments upon living animals, are of undoubted importance, in that they afford a comparison between pathological actions excited by unknown agents, and the phenomena manifested by living animals, under the influence of well-known morbific agents and poisons.

Our discoveries therefore, in the study of disease, may be the result of a simple act of consciousness, through an impression made on one or more of the senses; or they may be conclusions established by the higher powers of the understanding dealing with data, previously acquired by the senses and perceptive faculties.

The differences of opinion amongst medical men, are due more to the extent and character of their observations and studies, than to any real differences existing in the subjects of medical research. Mental and moral peculiarities, as well as the different objects for which the profession is followed, whether for the relief of suffering humanity, or for the gratification of personal aggrandizement and ambition, determine to a great extent those differences in professional creeds and practice which have led so many to doubt the inspiration of the oracle, whose utterances are found to be so changing.

It would appear to be impossible, but that the attention of observers should have been arrested, at an early period by the bold and gigantic features of a disease, which often attacks suddenly, without previous notice, throwing the system into great distress, with violent pain and numbness in the head and limbs, convulsions, delirium, coma and purple spots, upon the surface, and causing death within a few hours after the first appearance of disordered action.

In attempting to determine the precise period of the appearance of Cerebro-Spinal Meningitis in the history of mankind, we are however met with numerous and insurmountable difficulties.

Whilst there are passages in the writings of the Hebrews, and of some of the older writers, as Homer, Herodotus, Ovid, Plutarch, Pliny and others, showing that pestilence was both common and fatal in ancient times, and that the diseases which afflict modern armies, were not unknown to the ancients; on the other hand, the earliest and most celebrated writers, although embracing vast periods of time in their historical accounts, give but few and imperfect notices of the diseases which scourged populous kingdoms and decimated immense armies and navies. The absence from the writings of the ancients, of such minute descriptions of disease, as would enable the physician of modern times to determine with some approach to accuracy the nature and relations of different diseases, is referable to several causes. In most cases their works were compends of the knowledge of their times, and embraced vast periods, and covered such an innumerable number of civil, religious and warlike revolutions, that only the most prominent events were reccorded. Such writings were wanting in that personal and actual observation, which could alone secure accurate descriptions of disease. And further, as such writers were busied, chiefly with the origin, progress and decline of states, with the civil and military achievements and intrigues of kings, princes, statesmen and generals, the diseases and wounds of the common people passed almost unnoticed. The ancient kings, princes, statesmen and nobles, were continually haunted with the terrors of poison, and the object of medicine was rather to discover antidotes than remedies; the different classes of mankind, were more widely separated, and the higher ranks took comparatively little notice of the destruction by pestilence of thousands of slaves, or of the plebeian race.

Many populous nations of antiquity, were for ages, without any methodical records even of their civil, military and religious histories; and many of the most important events were preserved only in the dim and uncertain language of tradition.

Thus Justinian in his History of the World, extracted from Trogus Pompeius describes the Scythians, who were always regarded as very ancient, or of equal, if not greater antiquity than the Egyptians, as a people without landmarks, neither cultivating the soil, nor having any house, dwelling or settled place of abode, but being all engaged in feeding herds and flocks, and wandering through uncultivated deserts. wives and children were carried with them in wagons, which as they were covered with hides, were used instead of houses, and protected them against the rain and cold;—

were clad in the skins of wild animals, as the use of wool and clothes was unknown to them; their food was milk and honey; gold and silver they despised as much as other men coveted them, and justice was observed among them, more from the temper of the people, than from the influence of the laws. They were a nation hardy in toils and warfare; their strength of body was extraordinary; they took possession of nothing which they feared to lose, and coveted when conquerors nothing but glory.

Many powerful kingdoms have been utterly destroyed without leaving any record whatever of their literature and science, and their advancement in the arts may be inferred only from the monuments which have resisted the ravages of time. We certainly have but meagre accounts of the history of the "antediluvians," and only allusions to their progress in the arts; and no account whatever is extant of their diseases. Whilst we would infer from the "great age" attained by the "antediluvians," and the rapid multiplication of the race on the earth, that disease was rare, if not unknown, at the same time it must be confessed, that the closure of this immense period of time against all investigation of the origin of diseases amongst animals and man, should induce caution in those who attempt to define the period at which any particular disease has arisen. We have a striking example of the manner in which entire nations may be swept off by disease and battle, without leaving any trace behind them but their bones, rude earth monuments and stone implements, in the aborigines of North and South America. The red men as a race, are characterized by great energy, bravery and activity; they are not strangers to the highest sentiments of humanity and religion, and they developed both in North and South America, a civilization of a peculiar and in many respects wonderful character. And yet whole tribes and nations have been swept off by Small Pox, Syphilis, Whisky and the cruelties of their conquerors, without leaving a single written line to record their origin, religion, arts, wars or diseases.

Justin in his history of the world, although embracing a period of at least two thousand years, mentions only casually the diseases which had distressed mankind. Thus he simply records the fact that the famine which affected the retreating army of Xerxes, produced a pestilential distemper attended with such dire mortality that the roads were filled with dead bodies, and birds and beasts of prey allured by the carcasses, followed close upon the army. This author gives no account of the pestilence which afflicted Carthage, seventy-two years after its foundation, notwithstanding that it was so terrible as to lead to the establishment of the cruel religious custom of immolating human beings; in like manner, the pestilence which destroyed the army of the Carthagenian General Hamilco, in Sicily, is not described, but simply referred to a pestilential constellation, (pestilentis sideris,) although the entire city and country of Carthage was overwhelmed with grief at the news of the calamity, private houses were closed, the temples of the gods shut, all religious ceremonies intermitted, and business suspended. In the curious notice of the Jews, by Justin, there is an allusion to Scabies and Leprosy, as the cause of the expulsion of the Jews from Egypt, and the stringent laws of the Hebrews against intercourse with the surrounding nations, is attributed to their remembrance of the fact that they were driven from Egypt for fear of spreading infection. On the other hand, Justin is much more explicit and full in his description of the circumstances attending the diseases, wounds and mode of death of Alexander and other distinguished personages.

Cornelius Nepos, in his *Lives of Eminent Commanders*, makes mention of disease but in two passages; in the former an allusion is made to the destruction of Dyonysius, by some soporific potion administered by the physicians during his severe illness; in the latter, mention is made of a violent distemper of the eyes which afflicted Hannibal during his march over the chain of the Appenines, and which cost him the use of his right eye.

Eutropius in his abridgement of Roman History, alludes to diseases and pestilence only in the fifth chapter of the ninth book, where he states that the reign of Hostilianus and Volusianus was remarkable only for a pestilence and for other diseases and afflictions.

We search in vain, in the Historical works of Sallust, Florus and Vellerius Patuculus, for any information concerning the diseases and pestilence of the times of which wrote.

Tacitus, in his Historical works, whilst describing minutely the mode of [illegible] intrigues and the poisoning of noted personages, gives nothing of the symptoms which we might recognize the terrible pestilence which devastated Rome, in the time of Nero. Tacitus describes this pestilence as sweeping away every living thing, without any discernible derangement of the atmosphere, though the houses were filled with and the streets with funerals. Neither sex nor age were spared; bond and free, were snatched off indiscriminately, amidst the wailing of wives and children, who, while they were yet attending and lamenting the dead, were themselves stricken down and frequently burnt on the same funeral pile.

Titus Livius, the most elegant of Roman Historians, whilst recording in his History of Rome, the numerous and severe afflictions of this great city by pestilence, at the same time gives no such minute and accurate descriptions, as would enable the physicians of modern times to recognize the true nature of the diseases. Rome, situated in a malarious region, in the neighborhood of extensive marshes, was afflicted with pestilence of a most malignant character as early as the 16th year from its foundation, and years before the Christian era. Plutarch, in his life of Romulus says, that this plague killed instantly, without any previous sickness, and that even trees and cattle were not exempt from the malignity of its influence.

Thirty years after, in the 46th year of Rome, Italy was afflicted with severe pestilence of the nature of which we have no account, although Plutarch describes the institution of the Salii by Numa on this occasion.

During a period of five hundred and fourteen years, extending from B. C. 640 to C. 126, Livy records no less than fifteen plagues, which afflicted Rome, and writers have still farther extended this number.

Whilst from some facts, mentioned incidentally, in the descriptions of Livy and other historians, considered in connection with the topography and warm climate of Rome, and the season of the year in which the diseases arose, we are led to regard some of these plagues as of malarious origin, resembling in their symptoms and progress Billious, Congestive and Yellow Fevers, at the same time, the descriptions are so general and indefinite in their character, that nothing more than mere conjectures can be formed as to the true nature of the diseases.

Herodotus whilst giving casual but valuable observations with reference to the art of Medicine amongst the Egyptians and other nations, furnishes no detailed description of either the nature or the origin of specific diseases; and in like manner, the works of Strabo throw but little light on the history of diseases.

When we turn to the writings of those who have confined themselves strictly to Medicine, and attempt to determine the date of the origin of any special disease, we are met with difficulties as great as those encountered in the examination of the descriptions of diseases by purely historical writers. Many of the most ancient and celebrated medical writers did not busy themselves at all with inquiries into the histories of diseases; some simply recorded the facts and phenomena which passed directly under their own observation, whilst others simply reproduced, in new forms and in more general terms, the works of their predecessors, and immense chasms of time exist, in which we record whatever has been preserved of the diseases which afflicted mankind. The first body of doctrine in the history of medicine, is the collection of writings known under the name of the Works of Hippocrates; from the loss of the records of the earliest cultivators, the science of medicine mounts up directly to this source. In like manner there exists a great gap after the writings of Hippocrates; the works from his time to the establishment of the school of Alexardria, and those of that school itself, having been completely lost, with the exception of some quotations and passages preserved in the latter writings. It appears, however, that the Greeks received surgery, together with the other branches of medicine, from the Egyptians; and from some observations made by the learned men of the French Expedition to Egypt, in 1798, it is evident that in very remote times, this extraordinary people had made a great degree of progress in the art of surgery; upon the ceiling and walls of the temples of Tentyra, Karnack and Luxor, basso-relievos are seen, representing limbs that have been cut off with instruments very analogous to those which are employed at the present day for amputation. The same instruments are said to be again observed in the hieroglyphics, and vestiges of other surgical operations may be traced, which afford convincing proofs of the skill of the ancient physicians in this branch of medical science.

We are not to regard Greece as the birthplace of Medicine—we are to look, rather, to the early Egyptians as the first and most successful cultivators of Medicine. The *priests* of this ancient country were a numerous and influential body, receiving for their support about one-third of the whole income of the nation. Most of the Egyptian priests were skilled in medicine, and, as some suppose, practiced gratuitously among the people. "Here," says Herodotus, "each physician applies himself to one disease only, and not more—all places abound in physicians; some for the eyes, others for the head, others for the teeth, others for the parts about the belly, and others for internal diseases."

Pythagoras, who founded a great school of learning at Crotona, before assuming the business of teaching, spent much time in Egypt, and probably introduced much Egyptian science and learning into his celebrated course of instruction at Crotona, where medicine was first cultivated as a department of philosophy. From this school sprang some of the most distinguished physicians of that time, as Empedocles, Alcmæon, Democedes and Acron, who flourished near a century before Hippocrates. Aristotle, though not a practitioner of medicine, was of the family of Æsclepiadæ, and was well skilled in natural history, and the anatomy of the lower animals, as well as in the medical doctrines of his own and former times. Plato appears to have been well versed in the principles of the medical art, and is said to have divided medicine into five branches. Hippocrates, who is generally spoken of as the father of medicine, was born as late as the year 460 before the birth of Christ, and was, therefore, a cotemporary of Plato and Socrates, and lived more than a century after the establishment of the celebrated school of Pythagoras, and long after the foundation of the Temples of the Æsclepiadæ, devoted to the sick, and containing numerous votive tablets, in which their diseases were recorded. It is just to assume, therefore, that the history of medicine commences with the Works of Hippocrates, only because of the loss of the works of the older Egyptian and Grecian writers, from whom Hippocrates drew his instruction, and a large portion of his knowledge of medicine.

Rhazes, a Persian physician, who composed his works in Arabic, and who died at an advanced age, about the year 932, and who, consequently, wrote near one thousand years ago, affirmed that the extent of medical science at his day far exceeded the bounds of human life; and he goes on to say: "The authors who have improved this art are not a few, but they are not to be comprehended within the compass of a few years; a *thousand writers*, perhaps for a *thousand years*, have been improving this art and profession; and he that industriously studies those authors, will, in the short period of life, find out as much as if he had lived a thousand years himself, or employed those thousand years in the study of physic."

Now, this Rhazes is said to have been the ablest, and most distinguished physician of his age; a perfect master of the art of healing, skilled in its practice, and thoroughly grounded in its principles and rules, so that pupils traveled from distant countries to receive the benefit of his tuition, and his testimony, therefore, to the large number of medical works extant at his time, is worthy of all credence. And yet, not half a hundred of the thousand works to which he alludes, have come down to the present day.

Not only have many of the works of the ancients been lost, but it would also appear that amongst some of the greatest nations of antiquity it was impossible that any accurate history of diseases could have been written, because of the absence of both medical science and of physicians devoted to the treatment of diseases. Thus, Herodotus affirms that the Assyrians, even at the time of the greatest splendor and power of the

Babylonish Empire, had no physicians, but were in the habit of exposing the sick in the market place, that they might confer about their diseases with the passing multitude. If the passers by had themselves been afflicted with the same diseases as the sick persons, or had seen others so afflicted, they advised him to have recourse to the same treatment as that by which they escaped a similar disease, or as they had known to cure others. Herodotus also relates, that amongst that nation of the Indians called Padæans, who were Cannibals, it was the custom when any one of the community was taken sick, whether man or woman, for the nearest connections to put the sick person to death; and they justified this barbarous treatment on the ground, that if the sick person wasted with disease, his flesh would be spoiled. Those attaining old age, were, in like manner, sacrificed and devoured. Herodotus adds that few amongst them attained to the state of old age, for, before the limit of life waa reached, every one had been destroyed in consequence of some distemper.

The writings of Hippocrates, demand the first and most careful examination in all ininquiries relating to the history of particular diseases, not only from the position which they occupy in the history of Medical Science, but also, because, of all the ancient or more modern authors, Hippocrates studied with the most particular attention, and recorded with the most scrupulous accuracy the Natural History of Diseases.

In his work on Epidemics, Hippocrates states, that in Thrasus, after a cold wet autumn, during the winter, paraplegia or apoplexy set in, and attacked many, and some died suddenly. He also describes this sudden and fatal form of disease, as prevailing as an epidemic, whilst the people remained free from other diseases.

Galen in his Commentary remarks, that those attacks of apoplexy were caused by the cold winds of winter, succeeding to a humid autumn.

We have here a brief but pointed description, which applies more accurately to Cerebro-Spinal Meningitis, than to any other form of disease.

This disease should not be confounded with the *ardent fever* accompanied with "*phrenitis*", (delirium and coma), described by Hippocrates, and illustrated by numerous cases. Hippocrates described the ardent fevers, which prevailed during the autumn and early part of the winter, as characterized by acute fever, small, irregular, rigors, insomnolence, aberration of the intellect, thirst, nausea, circumscribed sweats about the fore-head and clavicles, but no general perspiration; much delirious talking, despondency, great coldness of the extremities. Paroxysms occurring on even days; and in most cases, on the fourth day, violent pains set in with cold sweats, the extremities could not be warmed, but were livid and cold; the urine was black, scanty, thin, and the bowels constipated, and the patients died about the sixth day with sweats.

This description evidently applies to the higher grades of malarial fever; the so-called Malignant, Remittent, Pernicious and Congestive Fevers. This view is still farther confirmed by a critical examination of the individual cases. Those who have practiced in malarious, hot, moist districts, similar to certain portions of Greece, will have no difficulty in recognizing the nature of the following case as described by Hippocrates.

Case 482: Pernicious Malarial Fever.

Erasimus, who lived near the Canal of Bootes, was attacked with fever after supper, and passed a bad night. The first day he was easy, but in pain in the night. Worse in all respects on the second, and at night delirious. On the third day, restless and very delirious. On the fourth day, dangerously ill—no sound sleep at night, but dreamed and talked, and afterwards appeared frightened and impatient. Early in the morning of the fifth day, came perfectly to himself, and was composed, but before noon, became so raving mad, that he could not contain himself. His extremities were cold and somewhat livid; urine suppressed; and about sunset he died. This patient's fever was continual, with sweats; belly tumified, distended and painful; urine black and cloudy; bowels not bound; thirst perpetual; and before he died, was strongly convulsed and sweated.

Hippocrates also described cases of febrile disease, characterized by the sudden onset, coma, delirium, and rapid fatal termination, which from the presence of glandular swellings, and tendency to putrefaction were evidently referable to the true *Plague*, the *Glandular Plague of the East.*

This great observer recorded fatal cases attended with delirium, convulsions and paralysis, which were examples of inflammation of the brain and spinal cord. In some of these cases, the inflammation of the Brain and Spinal Cord, was evidently the result of mechanical injuries, and the suppression of certain established discharges, as from the ears and nose; whilst others were examples of idiopathic inflammation of the membranes of the Brain and Spinal Cord.

The following cases resemble more nearly Cerebro-Spinal Meningitis than any other form of disease:

Case 483. Asandrus was chilly, had pain in his side and in his knees and thighs; after eating, grew delirious, and died in a short time.

Case 484. Polyphantus in Abdera, had a pain in his head, accompanied with violent fever. His urine was abundant, with thick turbid sediment.

The pain in the head not ceasing, medicines were ordered the tenth day, to produce sneezing; after which a violent pain in the neck attacked the patient. The urine was red and turbid, like that of a beast of burden. He rambled like a man in a phrenzy, and died in strong convulsions.

Case 485. The domestic, Eualcides, was affected in much the same manner. After passing thick urine and suffering with pain in the head, she became phrenitic and died in strong convulsions.

Case 486. The Halicarnassian was attacked in the winter with a violent pain in the ear and head. Bleeding afforded no relief. A phrenzy seized him and he died.

The compendious writers who followed Hippocrates, departed from his precision and fulness, in the record of special cases, and their descriptions of disease, although often elegant and highly finished, were wanting in those bold outlines and in those striking illustrations, which would enable the student to recognize such a disease as Cerebro-Spinal Meningitis, which possesses many symptoms in common with certain affections of the Brain and Spinal Cord.

If such elegant and renowned writers as Aretæus, and Paulus Ægineta, were acquainted with the disease, they included its description under the head of Phrenitis and Apoplexy; but in our researches we have failed to discover in the general and compendious descriptions of the older writers, following Hippocrates, a correct and unmistakable portrait of the disease under investigation.

The absence, therefore, of correct descriptions of this disease, from the writings of the various compilers of Medical Science, from the times of Hippocrates, to the establishment of Pathological Anatomy upon a Scientific basis, is no proof whatever, that Cerebro-Spinal Meningitis is of comparatively modern origin.

During the middle ages, Europe was frequently devastated by fevers of the most rapid and fatal character, often preceding and accompanying the *glandular plague*, which were characterized by the rapid evolution of fatal symptoms, the presence of spots and petechiæ, and by fierce delirium and profound coma. We recognize in the descriptions of the most accurate writers of those times, several forms of disease, as Typhoid and Typhus fevers, Measles and Scarlet fever, Erysipelas, Malignant Malarial fever, and Cerebro-Spinal Meningitis; all of which were frequently confounded in a general description of Putrid and Malignant fever and Pestilence; and it is incorrect to assume as some authors have done, that the Petechial and Spotted fevers, and the Black Death of those days, were in most cases identical with the disease, which we now call Cerebro-Spinal Meningitis. Thus if we select such an author as the learned Lazarus Riverius,* who wrote more than two centuries ago, and whose practice of physic reflected not only

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*The practice of Physic in seventeen several books, wherein is plainly set forth, the nature, cure, differences and several sorts of signs, together with the cure of all diseases in the body. By Nicholas Culpeper, Physician and Astrologer, Abdiah Cole, Doctor of Physic, and William Rowland, Physician. Being chiefly a translation of the works of that learned and renowned Doctor, Lazarus Riverius, sometimes Chancellor and Physician to the King of France, etc. *London*, 1668, pp. 611, 613.

the results of his own extensive experience, but also the views of the best physicians of the middle ages, we will find that Purpura, Spots and Petechiæ, were characteristic of the *continued fevers* of those times.

The Malignant and Pestilential fevers, described by Riverius, include both Typhus and Typhoid fevers, as may be clearly discovered by a critical study of the individual cases recorded in his work.

During the middle ages, the characters of the epidemic fevers, were modified and their destructive tendencies intensified, and their external manifestations rendered more marked by the neglect of all sanitary regulations in cities and private houses, and by the filthy habits and salt diet of the people. Every town was a fortress, and every house a castle, and the inhabitants, like the soldiers of a garrison, worked and slept with their arms, and always held themselves ready to resist attacks. Bands of robbers defied the power of the rulers, openly encamped upon the public roads, and plundered and murdered all who were not able to protect themselves by the force of arms. The country was covered with forests and undrained swamps and marshes, and the best lands were uncultivated. The wall-towns were encompassed by large stagnant ditches, which were the receptacles for refuse, and all sorts of decomposing filth; the streets were narrow, unpaved, undrained, uncleaned, and unlighted; there was no provision for the removal of the town refuse, which was thrown into the gutters and streets, forming in dry weather, a semi-fluid mass of corrupting animal and vegetable matter; and in wet weather, noxious bogs of filth. The houses were described as mean and squalid, without chimnies, the windows without glass, and the floors without boards. The floors, says Erasmus, "generally are made of nothing but loam, and are strewed with rushes, which being constantly put on fresh without the removal of the old, remain lying there, in some cases for twenty years, with fish bones, broken victuals, the dregs of tankards, and impregnated with other filth underneath from dogs and men."

From the absence of cotton and linen goods, and the scarcity of woolen garments, resulting from the slow production of cloth, by the hand looms, the personal habits of the people were filthy in the extreme. Combined with this, there existed ignorance as to the mode of raising and preserving vegetables, and improvidence and intemperance of living. No attention was paid to the collection and preservation of fodder, and the animals for the winter food, were slaughtered in autumn, and their flesh preserved by salting and smoking. Fresh animal food could be obtained only during the warm months of the year, and during the greater portion of the time, the common people subsisted chiefly on salted beef, veal or pork. The cultivation of the potato, and of gardens is of comparatively recent date, and fresh vegetables could be obtained only with difficulty, and in small quantities. For many centuries, no more subsistence was produced in Europe, than was barely sufficient for the necessities of the people, consequently every year of scarcity, became a year of famine. The malarious undrained state of the country, the crowded, filthy condition of the towns, and the filthy, degraded habits of the people, formed the most favorable conditions for the origin and spread of epidemic and contagious diseases, whilst the scorbutic state of the blood induced by the protracted use of salt meat, aggravated every disease, and tended to the formation of spots and petechiæ and exudation of altered blood, in all fevers. It is no easy task to unravel the complicated chain, and at this late day, decide dogmatically, the nature and relations of diseases, the descriptions of which, are given in loose and general terms, unsupported by post-mortem examinations. The difficulty is still farther increased, by the great revolution, which changes of diet, dress and habits, and the great advance of the arts of civilization, and the application in public and private buildings, and in cities and towns of correct sanitary regulations, have wrought in the character of diseases.

The plague which ravaged Europe, for more than two thousand years, disappeared near two centuries ago, and now only lingers in the more ancient and filthy Eastern cities; the labors of the Agriculturalist have banished Malarial fever from large portions of the European and American continents; Typhus or Jail Fever, the fatal scourge of the unfortunate prisoner, of the sailor and soldier, and of the inmates of the crowded hospital, and which in many of its visitations, was scarcely less terrible than the plague, is now confined to the hovels of the poor, in certain oppressed and suffering countries, and is almost unknown amongst the better classes; many painful and fatal forms of disease, which formerly swelled the bills of mortality, in the large European cities, have so completely disappeared, that the names even, are no longer in use; and small-pox, which before the discovery of vaccination by Jenner, was infinitely more destructive of life than the plague itself, sweeping off whole tribes of savages and half-civilized people, and destroying not less than *fifteen millions* of human beings, every twenty-five years, exists only because of our neglect and folly.

Several modern writers, who have traced the progress, and described the symptoms of Cerebro-Spinal Meningitis, have attempted to show, that an analogous disease, under the names of Spotted fever, Petechial fever, Cerebral fever, Phrenzy, Cephalalgia, Cold Plague, and Black Death, prevailed in different countries, from 1310 to 1830, when post-mortem examinations, more freely indicated its seat and nature, and led to a distinctive appellation, founded upon the characteristic anatomical lesions. In considering these statements, it is important however, to remember, that the terms Spotted fever, and Petechial fever, were frequently applied to severe forms of disease, as Typhoid and Typhus fever, which often in the severity of the nervous symptoms, and the rapidity of their progress, stimulated the disease under consideration, and it is difficult if not impossible to disentangle those epidemics which were beyond controversy Epidemic Meningitis. The confusion is rendered still more profound, by the view held by certain authors, that the disease is essentially a form of Typhus fever. And we are to look rather to future investigations, founded upon careful studies, and post-mortem examinations, for the establishment of the correct relations of epidemic Meningitis, to the malignant forms of continued and malarial fevers.

A disease resembling Cerebro-Spinal Meningitis, is said to have appeared in France, as early as 1310.

The Putrid fever, accompanied with Phrenitis, which prevailed in Westphalia Hesse, and Friesland, in 1480 and 1481, was most probably a continued fever of a severe grade.

In 1503, an epidemic prevailed in Europe, which was characterized by violent delirium, convulsions, contractions of the limbs, prostration and coma, and speedy death, sometimes in a few hours, but more often during the third or fourth day.

The epidemic Petechial fever of a malignant character, attended with extreme prostration of the powers, heaviness, alvine dejections, suppression of urine, spots about the fourth or seventh day, coma or complete insomnia, and finally hæmorrhages, which diminished the powers, and announced the approach of death, which prevailed all over Europe in 1505, and carried off an infinite number of sick, partook rather of the nature of malignant Typhoid fever, manifesting itself in Scorbutic patients.

Epidemic Encephalitis, and Malignant Pneumonia afflicted Germany in 1508.

The accounts of the Spotted fever, which prevailed in different countries of Europe, (and which was in several epidemics followed by the plague,) in 1510, 1516, 1517, 1556, 1557, 1564, 1569—1574, 1571, 1582, 1591 and 1592, are not sufficiently full or accurate to warrant the statement, that the disease was essentially epidemic Meningitis, although those epidemics may have included many genuine cases.

In 1553, after a very severe winter, a disease resembling Epidemic Meningitis carried off large numbers of the population in Silesia; and in 1580, associated with Catarrhal Affections, it is said to have killed no less than ten thousand persons in Rome, twelve thousand in Venice, and two thousand in Madrid.

During the Civil Wars in France, 1616, the Catholic and Protestant Armies, were decimated by a disease, which attacked by sudden and furious pain in the head, and destroyed almost all the victims.

The precise relationships of the punticular fever, spotted fever and petechial fever, which prevailed in different countries of Europe, during the seventeenth century, (1604, 1624, 1661–1664, 1691, 1693 and 1698,) have not been fully established; and it is not clear, that the disease described by Sydenham, as "*febris nova*," was epidemic Meningitis. The same obscurity hangs over the epidemics of spotted fever which prevailed in Prussia, 1704, in England, 1710–1741, in Piedmont, 1720, in Edinburgh, 1733, in France, 1746, 1756, 1757 and 1758, in Vienna, 1758, in Naples, 1764, in Tyrone, Ireland, 1765, in Tuscany, 1767, in Vienna, 1771 and 1772, in Cornwall, England, 1758. The fever which prevailed in the French Fleet in 1758, according to the description of Fousagrives, resembled more nearly a malignant Typhus; although possessing symptoms in common with epidemic Meningitis.

In 1788, during an epidemic of Typhus in Lyle, a disease appeared which was accompanied with tetanic convulsions and coma, the pia-mater being chiefly involved. A disease appeared at Geneva, in 1805, which resembled Cerebro-Spinal Meningitis, in its sudden invasion, severe pain in the head, rigidity of the spine, occasional petechiæ, engorgement of the brain, and heavy mortality. In this epidemic one quarter of those attacked died. The case which occurred at Strasburg the same year, appears from the results of the post-mortem examination to have been an example of inflammation of the brain and its membranes.

It is impossible to determine the date of the first appearance of this disease amongst the European settlers of North America. Noah Webster, in his *History of Epidemic and Pestilential Diseases*, alludes to several severe epidemics which were sudden in their appearance and rapidly fatal in their effects, the nature of which cannot now be determined with absolute accuracy. Thus he says, that in the winter of 1697, a mortal disease raged in the town of Fairfield, Connecticut, which was so general, that well persons could scarcely be found to tend the sick and bury the dead. Seventy persons were buried in three months, in this town, which contained less than 1000 inhabitants. Webster states, that in the same winter a deadly fever raged in the town of Dover, in New Hampshire; and he affirms, that "this disease was doubtless, that species of inflammatory fever attacking the brain and ending in typhus, which has often proved a terrible scourge to particular parts of America, during the rage of the pestilence in the last and of other epidemics in the country. We shall hear of it in the following century, and especially in 1761." Vol. 1, p. 210.

Webster also records the fact, that in November, 1760, the town of Bethlehem was assailed by an inflammatory *fever* with symptoms of typhus, which in the course of the following winter carried off about 40 of the inhabitants. "The disease was extremely violent, terminating on the 3d or 4th day; in some cases the patient died within 24 hours of the attack. It seems to have been that species of winter fever, which occurs in pestilential periods mentioned under the year 1698." According to Dr. Trumbull, of New Haven, the blood was very thick and sizy; after issuing from the nose, and sometimes from the eyes. The inflammation was violent and soon produced delirium. The most robust bodies were most liable to the disease. A free use of the lancet in the early stages of the disorder, was the only effectual remedy; where the physicians were afraid to bleed, the patients all died. This malady prevailed from November, 1760, to March, 1761.

Spotted Fever, first excited attention and alarm in America, in 1806, at Medfield, Massachusetts. It appeared in Liethfield County, Connecticut, in April, 1807, and continued in the towns of this State during 1808 and 1809.

In 1809 and 1810, it appeared in several towns in Massachusetts, New York, New Hampshire and Vermont; and in the latter State it continued during the winter of 1810 and 1811. The disease extended also to Canada, Pennsylvania, Kentucky, Northwestern Virginia, and finally to the Southern extremity of the United States. The symptoms and lesions of the spotted fever of the New England, States, as described by Jackson, Warren, North, Hale, Fish, Miner and Gallup, demonstrate in the clearest light that this disease was epidemic Meningitis, and not a continued fever. The value of this demonstration is not at all invalidated by the fact, that some of these observers recorded amongst their cases, examples of Typhus and Typhoid fever.

Drs. Thomas Welch, James Jackson and John C. Warren, in their reports to the

Massachusetts Medical Society, in 1810, upon this epidemic, describe the invasions of the disease as sudden and violent.

The following was given as a description of the disease as it occurred during this epidemic:

> "Unusual deadly coldness; skin white as polished marble, and smooth; countenance perfectly placid, not one distorted muscle; pulse at the wrist imperceptible; motion of the heart scarcely to be felt; respiration visible only by gasping, and that not frequent; and, as it were, only a step between this imperfect state of life, and death."

The post-mortem appearances, as detailed by the committee, were characteristic of epidemic Meningitis. In some instances of short duration, in which death occurred in from twelve to twenty-four hours, turgescence of the cerebral vessels was the only lesion found, bloody points in the medullary substance of the brain, effusion of serum, the arachnoid and pia-mater remarkably altered in appearance by the effusion of an opaque substance between them, which the committee likened to coagulated lymph, or semi-purulent lymph. This substance was frequently of the yellowish color of pus, with a consistence between the tenacity of lymph and the fluidity of pus.

At other times, the deposit resembled well characterized lymph. There was sometimes adhesion of the hemispheres of the brain to the dura-mater and to each other. In every instance examined, the small vessels of the surface of the heart were beautifully injected. Lymph was sometimes found on the pericardium, and the endocardium was occasionally altered from its healthy texture. Traces of inflammation were less frequently found in the pleuræ. No marked, or characteristic, or uniform morbid changes were discerned in the abdominal viscera.

Dr. Elisha North, in his "*Treatise on a Malignant Epidemic commonly called Spotted Fever*," published in 1811, describes several varieties or species of the fever.

Dr. North describes the milder form of the disease as resembling

> "A mild Typhus, or the fever attendant on Scarlatina; no petechiæ, but a red, fiery eruption, or what is perhaps more common, no eruption at all; pain in the head and limbs is less severe; less universal agony of the system; loss of appetite, nausea, but seldom vomiting or purging; no coma; no delirium; slight sore throat. This species or variety resembles the Scarlatina."

Dr. Joseph A. Gallup, in his "*Sketches of Epidemical Diseases in the State of Vermont, from its first settlement to the year 1815*, has given an excellent description of "*Spotted Fever*," and records, as the result of his post-mortem examinations of the brain, that

> "The blood-vessels in the brain, more especially the veins, are very turgid. The small vessels are injected with red blood, which, in a state of health, are destitute of it. The membranes of the brain exhibit different degrees of inflammation, according to the time of sickness, and degree of local affection in the brain. Signs of inflammation are discernible in almost the whole of the brain; the dura-mater adheres more strongly than natural to the cranium; also the brain beneath often adheres to its meninges. An increase of serous fluid is often discovered between the membranes, and the ventricles are more or less filled with the same, as in hydrocephalus. The anterior and inferior parts of the brain exhibit the greatest marks of violence, and everywhere a remarkable pressure in the veins."

Dr. Thomas Minor, in the "*Essays on Fevers and other Medical Subjects*," published at Middleton, Conn., 1823, has given illustrations of Spotted Fever, which he calls also (Phrenitis Typhoides), and says that

> "Spotted Fever appears to have its seat and throne in the brain, to belong nosologically to the passive phlegmasiæ. It is attended with no spontaneous reaction, but has the forming and suppurating stages blended together. This is manifest by the greatest arterial debility, typhoid delirium and convulsions, paroxysms of subsidentia, and in a word, by every symptom which is known to indicate an extreme deficiency or exhaustion of the powers of life."

We shall have occasion to refer again to the descriptions of these and other American authors, as Dr. James Mann, who has recorded observations upon this disease as manifested itself amongst the American Soldiers during the campaigns of 1812, and 1814, and we deem it to be unnecessary still farther to illustrate the nature of epidemic, which prevailed during the space of ten years, in various sections of United States, by quotations from the accounts of Dr. Southwick, of Albany, Hunt, of the United States Navy, Dr. Robert Dunbar, of Winchester, Va., Dr. Wilson, Dr. Utley, of Connecticut, Dr. Kercheval, of Bardstown, Kentucky, Dr. Bascom, of Grenville, New York, Dr. B. Vaughn, of Hallowell, Me., E. Mar Maryland, Dr. Joseph Trent, of Richmond, Dr. P. Herford, of Middleburg, Va. E. S. Davis, of Milledgeville Ga., Dr. John Kerr, of Mississippi, Dr. James Dav Columbia, S. C., Dr. Comstock and Dr. Hunting Sherrill.

Cerebro-Spinal Meningitis appeared 1816–17 in South Carolina and Massach 1818–1822, in Virginia, North Carolina and some of the Western States, Pennsylva Maine, Connecticut and Ohio; 1823, 1824, 1825, 1826, Connecticut; 1826, in Ne Orleans and Fort Adams; 1827, Ohio; 1832, Connecticut; 1845, 1846, Illi 1847, Mississippi, Tennessee, Missouri and Arkansas; 1847, 1848, Washington, D. 1848, Montgomery, Alabama; 1849, Mississippi; 1850, New Orleans; 1857, York; 1859, Virginia; 1861–1865, Northern and Southern armies, Indiana, Tenn North Carolina, Rhode Island, Philadelphia, Ohio, Alabama, Georgia, New Vermont, St. Louis, Missouri, Kentucky, Massachusetts, Washington, D. C.

It would be an error to suppose that no case occurred in the United States in years not mentioned above; for such a view could only be founded upon a knowle of the cases treated by the various practitioners of the entire country; and it is known that the vast majority never report their cases to the public prints. It appear that cases occur every year in one part or another of the country, and as a eral rule these have been reported to the medical journals only when several occurred in the same locality.

During this period, from 1806 to 1866, including the American history of disease, it appeared at various times, in different parts of Europe; 1807, in Blake near Ashburton, England, and in Briancou, Grenoble and Mayence; 1814, Gren 1814, Metz and University of Cambridge; 1813–1815, Dublin, Ireland; 1817, many and Italy; 1815, 1823, Millbank Penitentiary, near London; 1329–30, 1837, Bayonne.

M. Casimir Broussais has given a statement of the different accounts of the as it has appeared in France, which have been drawn up chiefly by the army and physicians.

First appearing at Bayonne, Bordeaux and Rochelle, in 1837, and afterwards at sailles and St. Cloud in 1839, it seemed to be fixed in these two latter towns 1842. From Versailles it launched off in one direction to Caen and Cherbou 1840 and 1841, and in 1839 and 1842. In a different direction it was met wi Laval, Mans, Chateau, Gonthier, Tours, Blois, and Joigny, in 1840–1841. Finally gained the neighborhood of Rambouillet. During all this time, the disease, with exceptions, as in Landes and Laval, Rambouillet and Strasbourg, was confined soldiers. In another quarter of the kingdom, but still in the South, the disease at Narbonne and Foix, in the year 1837, and thence, in 1838, broke out in but in the beginning of 1839, it showed itself at Nemis, where its attacks were to the garrison. In the winter of 1839–40, it appeared at Avignon, and again in following winter. In this town the soldiers were first attacked, but subsequently of the civil population were sufferers from the disease. In 1840 it broke out at rison, and at Lyons in the winter of 1841–42. Finally it branched off in another tion to Pupigan in the winter of 1840–41, and seemingly retraced its course to at Aigues-Mortes the following winter. In this last town, no part of the civil tion was exempt, children suffering equally with the military.

Epidemic Meningitis has appeared in other countries besides France; it has noticed in different cities of Italy, during the winters of 1837, 1839, 1840 and

and more particularly in the kingdom of Naples, where the physician designated it by the term Convulsive, or Apoplectico, Tetanic Typhus, etc.; in Gibraltar, the disease prevailed in the early part of the year 1844, but almost entirely among the civil population; 1840–1849, Algiers, from whence it extended towards the Great Sahara Desert; 1843–1849, various portions of France; 1845, 1846, Dublin, Ireland; 1849, Spain; 1846, 1847, Ireland; 1857, Sweeden; 1845–1848, it prevailed with great malignancy in Denmark; 1845–1861, Sweeden and Norway; 1860–1861, Holland; 1860, Paris; 1863–1865, Germany.

It is without doubt true, that it is difficult clearly to distinguish the characters of many of these epidemics; and the statements of those writers who make no distinction between Typhus and Typhoid fevers, and use the term Cerebro-Spinal Meningitis as synonymous with *Spotted Fever*, must be received with great caution; and it should be borne in mind, in such inquiries in the histories of these and related diseases, that it is only since 1836, that pathologists have distinguished the characteristic lesions of Typhoid fever, and established absolute and recognizable differences between this disease and Typhus fever, and that the nature and pathology of Cerebro-Spinal Meningitis are still matters of dispute with many pathologists.

We conclude from this very general outline of the history of Cerebro-Spinal Meningitis:

1st. Cases of Cerebro-Spinal Meningitis, appear to have been observed by Hippocrates.

2d. Cerebro-Spinal Meningitis has prevailed at various times, and in all countries, and it appears to have been governed by no fixed laws as to duration, origin, locality and climate; its outbreaks have occurred simultaneously in the most widely separated countries presenting the most diversified conditions of soil and climate, and it has attacked alike the most salubrious and healthy towns.

3d. Cerebro-Spinal Meningitis originates de novo, at the same time in widely separated centres; and in its spread appears to be governed by no such fixed laws as regulate the spread of special contagious forms of disease, as Small-Pox, Measles and Scarlatina.

4th. The most fatal and wide-spread epidemics of Cerebro-Spinal Meningitis have occurred in mid-winter, and no relationship can be traced between its origin and spread, and miasmatic exhalations similar to those which cause the various forms of intermittent, remittent and congestive malarious fevers.

5th. In the irregularity and uncertainty of its origin and progress, Cerebro-Spinal Meningitis resembles more nearly the Phlegmasiæ, as Pneumonia and Pleuritis, and it appears to be dependent more upon pre-existing states of the constitution and sudden changes of the temperature, than upon the existence of any peculiar fibrile poison.

Cerebro-Spinal Meningitis, (Myelitis Petechialis, Cerebral or Cerebro-Spinal Typhus, Ménegite Cérébro-Spinal, Fiévre Cérébro-Spinal; Typhus Cérébro-Spinal,) attracted my attention at an early period of the recent civil war, and I sought opportunities for observing its symptoms, and of gathering its history in various portions of the Confederacy, by an examination of the field and hospital reports of different departments, and of the records of the Surgeon General's Office at Richmond, Virginia, and by personal conference with surgeons in the field and hospital. The sudden termination of the war, found my labors upon this disease, in an unfinished state: the value of all facts however incomplete, which bear at all upon the nature of this obscure and almost universally fatal disease, rather than the expenditure of health and strength necessarily required in these investigations, have induced the record of the following observations.

Whilst I have made some research into the literature of Cerebro-Spinal Meningitis, in the Southern States, it is not my intention to do more than call attention to the first author (as far as my information extends) who noticed this disease in the Southern Atlantic and Gulf States.

Bernard Romans, an enlightened observer, who spent several years in Florida, published in 1776, a work, entitled "*A Concise Natural History of East and West Florida, containing an account of the Natural Produce of all the Southern Parts of*

British America, in the Three Kingdoms of Nature, particularly the Animal and Vegetable. etc.," in which occurs the following allusion to a disease resembling in its seat, symptoms and rapid termination, Cerebro-Spinal Meningitis:

> "In Georgia I saw one or two instances of a disease among blacks, to which the people give the odd name of the pleurisy of the temple, of the forehead, of the eye, and so on; I am told they have a pleurisy for every part of the head. It is violently acute and, as I am informed, proves sometimes fatal in ten or twelve hours time; if immediately on its attack, a quantity of blood is not drawn from the arm; for the rest, this disease is treated like a pleurisy, p. 249."

In the southern part of Georgia, in which Bernard Romans, made these observations, recorded in his exceedingly *rare* work, ninety-nine years ago, the term *Head Pleurisy*, is sometimes at the present day, applied by unprofessional people, black and white, to Cerebro-Spinal Meningitis.

During the months of August and September, 1863, I examined all the sick, wounded, sanitary and mortuary reports on file, in the Surgeon General's Office in Richmond, Virginia.

Up to the time of this examination, Cerebro-Spinal Meningitis had not been entered upon the reports of the sick and wounded as a distinct disease. The omission of this disease from the official classification of diseases, issued from the Surgeon General's Office, and according to which all returns from Medical Officers were made, was unfortunate, as it was hence impossible to determine from these records, the relative frequency of this disease in comparison with other nervous affections, the rate of mortality, or the effects of locality, season and climate. I classified and consolidated the following tables of Nervous Diseases from the Official Reports of Medical Directors, on file in the Surgeon General's Office, Richmond, Virginia, August 1863.

TABLE.

Diseases of the Brain and Nervous System, recorded in the Field Reports of the Army of the Confederate States of America, during nineteen months, January, 1862 to July, 1863. Classified and Consolidated from Official Reports on file in the Surgeon General's Office, War Department, Richmond, Virginia, August, 1863, by Joseph Jones, M. D. Surgeon, Provisional Army, Confederate States.

	DISEASES OF BRAIN AND NERVOUS SYSTEM.															MEAN STRENGTH AND TOTAL CASES DISEASES AND WOUNDS.		
YEAR AND MONTH.	Apoplexia..........	Cephalalgia	Cerebritis...	Chorea..........	Delirium Tremens.	Epilepsia..........	Ictus Solis..	Irritatio Spinalis...	Mania	Melancholia..........	Meningitis	Neuralgia..........	Paralysis	Tetanus	All other diseases of this class.......	Mean strength, Officers and Men	Total sick and wounded, entered during month.....	Aggregate sick and wounded.....
January, 1862.....	16	352	36	14	34	87	...	50	5	7	54	1133	22	8	114	232,138	90,757	115,416
February, "	7	324	22	3	36	39	3	36	6	5	29	1177	13	9	59	219,069	71,672	96,463
March, "	3	239	17	4	18	35	2	44	6	6	9	871	30	10	34	165,047	50,385	63,387
April, "	6	261	13	...	12	16	5	42	2	2	14	381	14	4	17	58,304	23,243	27,539
May, "	2	246	13	2	4	15	13	16	7	3	6	261	5	1	29	58,690	25,985	30,491
June, "	7	481	19	5	4	44	14	83	6	21	21	757	42	2	40	136,362	78,583	94,467
July, "	10	347	2	1	4	29	16	48	2	12	17	649	16	2	59	79,999	41,700	55,097
August, "	16	253	9	1	4	33	20	23	1	16	3	442	36	5	32	113,407	50,987	64,436
September, "	1	266	7	2	6	28	10	14	1	2	8	300	15	1	11	125,408	42,450	51,422
October, "	11	323	12	2	13	49	5	66	2	5	6	566	48	...	40	156,734	48,606	59,841
November, "	7	342	16	5	18	52	12	72	6	22	32	950	39	1	32	270,480	71,328	90,472
December, "	25	266	34	4	4	47	18	78	2	13	31	689	40	4	28	172,800	67,461	85,769
January, 1863.....	3	233	16	6	6	51	5	85	7	15	36	1118	53	5	28	192,776	76,620	96,053
February, "	14	302	11	3	2	67	6	50	4	11	36	822	62	2	35	215,458	60,135	80,889
March, "	14	455	28	2	10	75	4	79	11	4	54	1184	121	8	56	313,848	92,788	117,171
April, "	15	375	24	4	11	62	4	154	12	10	51	558	137	6	40	190,518	60,467	74,886
May, "	19	315	14	3	3	60	7	41	3	26	30	519	101	4	36	163,711	48,589	63,211
June, "	3	222	4	2	2	20	24	18	1	6	27	154	44	...	20	107,153	33,805	43,134
July, "	3	180	2	...	3	15	14	14	2	7	12	254	11	...	8	72,396	20,849	24,847
Total..................	182	5732	299	63	194	824	182	1013	86	193	476	12,785	849	72	718		1,056,349	

TABLE.

Diseases of the Brain and Nervous System, recorded in the Hospital Reports of the Army of the Confederate States of America, during nineteen months, January, 1862, to July, 1863, Classified and Consolidated from Official Reports on file in the Surgeon General's Office, War Department, Richmond, Virginia, August, 1863, by Joseph Jones, M. D. Surgeon, Provisional Army, Confederate States.

	DISEASES OF THE BRAIN AND NERVOUS SYSTEM.															TOTAL SICK AND WOUNDED.	
YEAR AND MONTH.	Apoplexia	Cephalalgia	Cerebritis	Chorea	Delirium Tremens.	Epilepsia	Ictus Solis	Irritatio Spinalis	Mania	Melancholia	Meningitis	Neuralgia	Paralysis	Tetanus	All other diseases of this class	Total sick and wounded entered during the m'th.	Aggregate sick and wounded entered during the m'th.
January, 1862	2	1	2	1	1	2	...	2	1	3	13	15	3	...	5	3293	5727
February, 1862	1	4	3	...	2	1	...	1	...	1	3	15	3	...	2	2472	4798
March, 1862	4	3	...	...	4	5	...	3	...	1	3	18	4	...	3	2341	3999
April, 1862	...	13	3	...	2	2	...	3	1	...	4	29	1	...	3	2543	6784
May, 1862	...	5	7	...	1	6	1	7	1	5	3	57	6	...	8	9700	14,067
June, 1862	1	28	3	2	2	5	...	22	...	2	7	104	20	1	10	16,605	26,120
July, 1862	1	8	10	2	1	10	4	13	3	4	44	87	21	...	9	18,918	28,437
August, 1862	3	47	6	3	2	117	10	15	3	...	10	177	23	1	9	21,546	31,662
September, 1862	5	52	5	3	1	38	5	124	5	22	6	247	47	1	14	46,733	55,726
October, 1862	5	35	7	5	3	36	1	59	5	1	6	134	47	5	10	39,170	53,970
November, 1862	5	37	3	4	8	36	...	92	9	9	15	286	56	21	8	44,890	50,164
December, 1862	4	3	6	3	7	30	...	25	6	4	5	153	26	...	12	29,032	44,282
January, 1863	4	2	11	1	5	9	...	12	5	...	2	67	32	...	13	12,542	27,784
February, 1863	6	2	4	1	1	12	6	10	5	2	5	78	12	...	14	13,378	28,652
March, 1863	2	12	6	...	9	21	...	23	3	...	12	88	25	1	6	12,809	24,812
April, 1863	1	8	6	1	1	18	3	23	5	1	14	105	30	2	8	14,884	26,628
May, 1863	5	17	4	5	4	33	7	46	8	...	7	165	63	13	23	41,889	57,822
June, 1863	2	37	2	3	2	26	6	51	3	...	5	183	69	1	22	27,389	46,702
July, 1863	4	22	2	7	1	27	15	40	7	1	2	127	51	1	5	37,073	55,708
Total	55	336	90	41	57	434	57	571	70	56	156	2135	539	47	184	398,641	

As Cerebro-Spinal Meningitis did not appear in the classification of the Medical Department of the Confederate States, the cases of this disease were most probably entered upon the field reports and hospital registers, under several heads, but chiefly under the head of Meningitis. Some cases may have been recorded under the heads of Apoplexia, Cephalalgia and Cerebritis, but certain considerations, render it probable that the largest, numbers were recorded under the head of Meningitis.

Out of more than one million cases of sickness and wounds entered upon the field reports during nineteen months, January 1862, July, 1863, only 476 cases of Meningitis were recorded; and in nearly four-hundred thousand cases of disease and wounds, entered upon the hospital reports, during the same period, only 156 cases of Meningitis appeared; from these facts, therefore, as well as from extensive personal observation and inquiry, I conclude that Cerebro-Spinal Meningitis did not prevail to any great extent amongst the Confederate soldiers. In its appearance among the armies serving in different portions of the Southern States, its victims did not amount to such a number, in any one district, as to at all countenance the view that the disease possessed any of the characteristics of a contagious fever; and the disease during the recent war, appeared to obey no well defined laws of climate, season, or of geological and physical conditions.

The mortality records of the Confederate Army, were carefully examined with the design of determining the mortality produced by Cerebro-Spinal Meningitis. During the period of nineteen months, I found only one death recorded as due to this disease, and this occurred in the month of March, 1862, and in the District of Aquia, commanded by Major General G. W. Smith. The following table presents the number of deaths from Meningitis, recorded upon the Field and Hospital Reports during this period.

TABLE.

Deaths from Meningitis in the Confederate Army, during nineteen months, January, 1862, to July, 1863. Field and Hospital Reports, Consolidated from the Official Reports on file in the Surgeon General's Office, War Department, Richmond, Va., August, 1863, by Joseph Jones, M. D. Surgeon, Provisional Army, Confederate States.

YEAR AND MONTH.	DEATHS F'M MENINGITIS.	REMARKS.
Jan'ry, 1862..	16	5 deaths in Army of Potomac, Gen. Joseph E. Johnston. 8 deaths in Department of North Carolina. 1 death in Military Dist. of Ga. 1 death in Military Dist. of So. Ca. 1 death in Military District of Florida.
Febr'y, 1862..	4	4 deaths in Army of Potomac.
March, 1862..	6	1 death from Cerebro-Spinal Meningitis in Dept. of Aquia. 1 death, Meningitis, in General Hospital, Va. 1 death, Field Reports, So. Ca. 3 deaths, Hospital Reports, So. Ca.
April, 1862...	5	2 deaths. Mil. Dist., N. C. 3 deaths, Mil. Dist., Ga., So. Ca. and Fla.
May, 1862.....	5	1 death, General Hosp., Va. 1 death, Mil. Dist., N. C. 3 deaths, Mil. Dist., So. Ca., Ga. and Fla.
June, 1862....	......	
July, 1862.....	41	32 deaths from Meningitis in General Hospitals of Virginia. 5 deaths, Mil. Dist. of So. Ca., Ga. and Fla. 1 death, Army of the West. 2 deaths, Mil. Dept. of the Gulf.
August, 1862	7	3 deaths, General Hospitals, Va. 1 death, Dept. So. Ca., Ga. and Fla. 3 deaths, Army of the West, Gen. Bragg.
Sept. 1862....	3	1 death, Army N. Va., Gen. R. E. Lee. 2 deaths, General Hosp. Va.
October, 1862	3	1 death, General Hosp. Va. 2 deaths, Dept. of the Gulf.
Nov'ber, 1862	6	1 death, Gen'l Hosp., Va. 1 death, Mil. Dept. S. Ca., Ga. and Fla. 1 death, Army of Tenessee. 3 deaths, Mil. Dept. of the Gulf.
Dec'ber, 1862	10	1 death, Gen'l Hosp., Ga. 1 death, Gen'l Hosp., So. Ca., Ga. and Fla. 1 death, Army of Tennessee, Gen. Bragg. 2 deaths in army, serving in and around Vicksburg. 5 deaths, Army of Tennessee.
Jan'ry, 1863..	13	4 deaths in Va.; 6 deaths in army, in and around Vicksburg. 1 death, Army of Tennessee.
Febr'y, 1863..	15	2 deaths, Dept. N. C. 2 deaths, Army of Tennessee. 7 deaths, Va. 4 deaths amongst forces serving in and around Vicksburg
March, 1863..	25	6 deaths, Army of N. Va. 4 deaths, Gen'l Hospital, Va. 1 death, Mil. Dist. S. W. Va. 2 deaths, Army of the Gulf. 7 deaths, Army of Tenn. 1 death, Army at Mobile. 1 death, Vicksburg. 3 deaths, So. Ca., Ga. and Fla.
April, 1863...	15	7 deaths, Va. 3 deaths, Army of Tenn. 2 deaths, E. Tenn. 1 death, Vicksburg. 2 deaths, So. Ca., Ga. and Fla.
May, 1863.....	8	1 death, Va. 2 deaths, Army of Tenn. 3 deaths, Vicksburg. 1 death, N. C. 1 death, So. Ca., Ga. and Fla.
June, 1863 ...	10	1 death, Va. 5 deaths, Army in and around Vicksburg. 1 death, N. C. 2 deaths, So. Ca. 1 death, Army of the Gulf.
July, 1863....	2	1 death, N. C. 1 death, Army of the Gulf.
Total........	194	

From the preceding table, it will be seen, that 194 deaths were recorded upon the Field and Hospital Reports, as due to Meningitis. The largest number of deaths from this disease occurred in the month of July, 1862, and 32 of the 41 deaths, recorded as due to Meningitis during this month, occurred in the General Hospitals of Virginia. The number of deaths from this disease in the General Hospitals of Virginia, during July, 1862, very nearly equalled the number of cases reported.

arge armies operating within and around Vicksburg, lost 23 men of Meningitis. months.

cases show that, more than one-third of the cases reported as Meningitis ter- fatally. Cerebro-Spinal Meningitis was almost universally fatal amongst the rate soldiers; we conclude therefore that only a portion of the cases of Menin- re truly Cerebro-Spinal Meningitis. Owing to certain causes the reports on file Surgeon General's Office, were incomplete—this imperfection being referable o sudden military movements, and the consequent loss or delay of documents. ea of the imperfect nature of the reports, will be gathered from the fluctuations umber of officers and men upon the field reports; nevertheless the statistics are as far as the numbers, viz; the mean strength of officers and men, and the to which they were subjected.

reful examination of the Sanitary, Medical and Surgical reports on file, in the S. P. Moore, Surgeon General C. S. A., and in the hands of Surgeon F. Inspector of Hospitals, disclosed the following interesting papers relating to -Spinal Meningitis.

ese papers possess historical, as well as medical interest, they are given in full, ied them in the office of the Inspector of Hospitals, in Richmond, Virginia, , 1863.

S RELATING TO A VERY FATAL MALADY WHICH OCCURRED AMONGST SOME OF E TROOPS OF THE ARMY OF NORTHERN VIRGINIA, SUPPOSED TO HAVE BEEN REBRO-SPINAL MENINGITIS.

port of Sick and Wounded in 10 Companies 22d North Carolina Regiment, tioned at Camp Gregg, near Fredericksburg, Virginia, April, 1863, by P. rvais Robinson, Surgeon P. A. C. S.

tion is respectfully called to four cases of Meningitis which occurred in this command the month of April. They were all members of the same company, (G).

e three who died, J. P. Faison and Haywood Faison were brothers, and of these H. was a brother-in-law. These were conscripts, having been in camp about one previous to the appearance of this disease, and occupied the same tent; the fourth rdee, who recovered, was an old soldier, having been in service since the commence- the war.

ifficult to assign any special circumstance, or combination of circumstances, as caus- fearful malady. The troops were at this time exposed to no influences other than rdinarily incident to camp life, yet it is somewhat remarkable, that of the four cases, ould have been of the same family.

87. J. P. Faison was taken sick on the 11th day of April. He complained of slight e, but persistent, with a general indisposition to muscular exertion. Tongue rather otherwise normal in appearance. Pulse 90 to 100, but not abnormal in force or Bowels somewhat constipated. Skin natural. ℞. Olei Ricini f℥ii.

12th.—In same condition, with some disposition to sleep; still complains of head- had several evacuations from the bowels.

14th, as there has been no abatement of the pain in the head, applied a blister to the he neck.

15th. Died this morning about 6 o'clock.

re were no symptoms of disease in this case apparently sufficient to account for death, d, to enable us to form an idea with any degree of confidence as to the pathology of dy which ended so unexpectedly and suddenly, we determined to institute a post- examination.

ess myself, as well as my assistant, to have been completely deceived as to the gravity ase, and, indeed, we were inclined to suspect mallingering; I, however, withheld the on of such suspicion, though another surgeon in the brigade, on whose judgment I oncurred in my view of the case.

headache was the only persistent symptom, it was not unreasonable to look to the the seat of the disease; and on removing the calvarium and dura-mater, on the sur- the brain were seen collected a yellow or light, straw-colored exudation, situated the arachnoid and pia-mater, which, on examination, appeared to be coagulable lymph. On puncturing through the arachnoid into these patches, there escaped a thin, serous looking fluid, the larger part of the collection remaining adherent to the inclosing membranes, but could be easily removed with the end of the scalpel; at some few points, the arachnoid and pia-mater were firmly adherent. The latter membrane was more or less injected throughout its extent. The ventricles contained no abnormal amount of fluid. The thoracic and abdominal organs were healthy, with exception of the summit of the right lung, which was found to have been disorganized by old tuberculous disease.

As Watson remarks, such cases teach us that serious lesions of the brain can exist, and even terminate fatally with scarcely a symptom of sufficient gravity to warrant even a suspicion of disease.

Cases 488, 489, 490.—Of the other three cases which immediately succeeded this, the symptoms were well marked, and the disease readily recognized, they being ushered in by the most violent paroxysms of mania, requiring the restraint of several attendants.

Post-mortem examinations were also made in the case of Haywood Faison, and H. Williams, the appearances being much the same as those presented in the first case, except that in the two latter cases there was greater evidence of disease, the effusions between the membranes being more extensive, and the ventricles being in both distended with fluid. The largest effusion in all these cases was to be found about the root of the spinal cord, (medulla oblongata), and accounted for the mode of death, which was by a paralysis of respiration.

In the two latter cases there was considerably more evidence of disorganization, which was in accordance with the greater protraction of the disease.

The usual antiphlogistic remedies, such as purgatives, counter-stimulants to back of neck and spine, cold to head, stimulant injections, were applied in the early stage, and stimulants in the latter, or that of collapse, but with very discouraging results, having lost three out of four patients.

The question of venesection was duly considered, but it was concluded that in not one of the cases was such practice admissible, they, like most cases of disease in camp, wanting that character which would justify the abstraction of blood.

P. GERVAIS ROBINSON,
Surgeon P. A. C. S.

2. *Report of W. D. Mitchell, M. D., Sen. Surgeon Rhodes' Brigade.*

Headquarters Third Alabama Regiment,
February 21st, 1863.

Surgeon Hunter McGuire, Medical Director:

Sir:—I feel it a duty that I owe to those under my charge, as well as to my professional reputation, when a disease of unusual fatality has made its appearance in camp, resisting all those remedial agents dictated both by theory and what little practical experience I have had, not only to report the existence of such, but to make such efforts as would naturally suggest themselves in the absence of all books of reference. * * *

The following case is one of six fatal cases which have occurred in my regiment, all similar in the symptoms, with a few trifling and unimportant variations.

It is well to remark, that in every instance the subjects have been robust, healthy men, and in the prime of life.

Case 491.—Sergeant A. Gemeany, Third Alabama Regiment, aged 28 years, tall and robust; had been unusually healthy since his enlistment, nearly two years. On the morning of the 5th of January, he was taken with a severe chill, attended with vomiting; pains in the abdomen; the bowels were constipated; he suffered during the day with severe headache and pains in the back and neck, the feeling of chilliness continued; he was perfectly sensible during the day, talked to his friends in a natural manner, and partook of food in the shape of soup, at the dinner house; he continued in this condition until about 10 o'clock P. M., when a convulsion caused his mess-mates to call me to see him; they had, up to this time considered his case as one of chill and fever, and paid but little attention to the matter; this convulsion, which they described as exceedingly violent, and of nearly an half hour's duration, were the first symptoms to excite their fears.

I did not see the case until after the termination of the first convulsion, but upon arriving at his tent, found him in a condition very much resembling the state of collapse of Cholera Asiatica, (stupid, could be aroused when spoken to in a loud voice, or when shaken, but his answers to questions when propounded, not very intelligible), surface of body cold, and covered with bluish red particles, such as are seen in Hæmorrhagica Purpura.

There were not at this time any symptoms of either paralysis or tetanus; the pulse was full, but very slow, the pupil contracted, but responding readily to the action of light; the respiration was labored, and there was a constant flow from the nostrils of a yellowish, slightly fœtid fluid. This condition continued without the appearance of other symptoms, until about 1 A. M., when a species of reaction ensued, severe and entirely uncontrolable. (Expecting this, from the condition of the pulse upon my first examination, I had made the attempt, notwithstanding the appearance of collapse, thinking that the condition of the pulse warranted me in this, to lessen the quantity of blood, by opening the Temporal Artery, but the blood refused to flow, as it did also from the arm).

Convulsion, or, more properly, spasm after spasm, in rapid succession, ensued. The efforts at respiration became painful to the beholder, muttering delirium followed, after about two hour's duration of this condition; the intestines had remained cold during the whole of this time; respiration became less labored, the pulse was now fast and thready. At 8 o'clock the next morning, I found the patient fast sinking, the mutterings had ceased, respiration was slow but not labored, the pulse very fast, but scarcely perceptible, the pupil preternaturally dilated, and not responding to the action of light, sphincters relaxed, the entire surface of the body cold, and the spots before spoken of very much increased. With these symptoms gradually increasing, the patient died at 9 o'clock.

In reviewing these symptoms, to find either a name for the disease, or to draw some analogy with some disease already named, I must confess that my efforts have been rewarded by no conclusion at all satisfactory to myself.

Two diseases, Cerebro-Spinal Meningitis and Typhoid Fever have elicited my attention, to either of which I find many points of resemblance, though I must say, many points of difference also. In my earlier investigations of this subject, I had almost yielded to a conclusion that it was certainly Cerebro-Spinal Meningitis, but the existence of the disease as an epidemic, and the absence of all pre-disposing and exciting causes, or rather such as in my opinion would be so considered, has caused me lately to lean very much towards the Typhus nature of the disease. In this I am borne out by the existence of many cases of pain in the head and back. Mild cases, (I think that many of the cases sent off as suspected Small-Pox come under this head), resembling the symptoms which usher in the disease, also the existence of many cases of low forms of fever, I am satisfied that the disease, be what it may, is epidemic, and perhaps contagious.

Hoping that you will excuse any imperfections which may be apparent in the hastily prepared paper, I would most respectfully ask your early action in this matter.

I am sir, very respectfully, your obedient servant,
W. D. MITCHELL,
Sen. Surg., Rhodes' Brigade.

P. S. I have seen in my Regiment, the 3rd Alabama, 8 cases perfectly well marked; six (6) were fatal.

3. *Report of J. T. Banks, M. D., Surgeon 13th Regiment, Ga. Vols.*

CAMP NEAR FREDERICKSBURG,
Med. Dep., 13th Ga. Reg., March 28th, 1863.
Near Hamilton's Crossing.

Surgeon Hunter McGuire, Medical Director:

SIR.—The following description of the fifth case may be considered typical of them all, in the main features presented by the cases in their short, rapid and fatal course. All were stout, healthy soldiers, three or four of them careless of protection, confident in their physical endurance, and all inured to camp life; ages from 19 to 27 years.

CASE 492. Thompson, Company F. 13th Ga., age 24, healthy and quite stout. Felt well and ate a full meal for supper on the 13th inst., complained of feeling a little bad at bed-time, when his brother prepared his pallet, and he retired as he thought to sleep it off, but in place of sleep, continued to complain until he was attacked with a chill, which lasted several hours. His brother reports that he vomited freely while his chills lasted, but on close inquiry I learned that he vomited only his supper. Called to see him at 4 A. M., 16th inst. Chill had passed off, and fever rising, pulse 100, volume over natural, but soft and compressible. Skin warm, face flushed with a slight purple tinge; eyes injected and bathed in a profuse lachrymal flow, mixed with mucus; pupil natural in size and action. Expression dull and dejected. Tongue coated, white and moist; head easy; mind clear; respiration of a moaning character, but full and easy when engaged in conversation, and without cough. Bowels acted well on previous day. Pain very severe in both legs, and in them alone would he acknowledge to any pain, but so severe in them that he would often beg for something to ease them, saying they would kill him they pained him so. Great thirst, gave him Opii gr. ss, Calomel and Ipecacan, grains iii.

Called again at 6 o'clock, A. M. Condition same. I applied cups to nape of neck and drew 2 ozs. of blood, but stopped on account of depression. Learned that his supper was liberal, and among other things ate freely of peas, and seeing no effects from the dose of medicine, I determined to evacuate his stomach by means of a large warm draught with Ipecac, that I might get rid of any offending matters, arouse his liver to action and facilitate the subsequent absorption of medicine. The matter ejected was the fluid which the patient had just ta with a little glairy mucus—no appearance of any bile.

Seven o'clock, A. M. A little change in the blush of his face, the purple tinge has slightly with a little more depression in his circulation. (Quinine, grs. iv; Camphor, gr Capsicum, grs. vi; Calomel, grs. iii; mix administer at once, and repeat every hour; Plaster over the entire length of the spine).

Ten o'clock, A. M. Circulation has failed; rapid pulse at wrist, can only be felt every 5th beat. Cardiac impulse quite feeble. Continue treatment.

Noon. No pulsation at wrist; purple tinge of face increasing. Pain continues Though pulseless, the patient is able to rise from his pallet, and with the aid of two walk out of his hut and evacuate his bowels. (Continue medicine; repeat Mustard to also apply Mustard to abdomen and front of chest.)

Two o'clock, P. M. Purple tinge of face deepening, skin cool; no redness of skin Mustard; pain in legs intense. No effect from treatment. (Continue treatment with of Sulphate of Morphia in next dose).

Six o'clock P. M., condition same; no relief from pain by Morphia. Skin cold extremities. Flush of face changed to a mottled, purplish hue. (Camphor and Am Julep, continue Quinine and Capsicum).

The patient continued to sink, and died at 11 o'clock P. M. His mind continued clear he complained of the same pain as long as he could speak. Had two actions on his during his illness.

Post-Mortem 12 *Hours after Death—External Appearance.*—Features very little changed, quite stiff and cold, some warmth of body. Skin discolored by the extravasation of Muscles over chest and in parietes of abdomen natural. Liberal supply of adipose tissue.

Abdominal Viscera.—No change in the peritonæum. Small intestines a little injected. change in the appearance of the large intestines. Cœcum, ascending and transverse contained some fœcal matter. Bladder full of urine.

Spleen almost twice its normal size. The comparative increase of weight of this organ have been greater than the increase of size, judging from its weight in handling it; color, friable, and bleeding very freely when torn.

Gall-bladder distended to a great size by yellow, healthy-looking bile—no obstruction its exit.

Viscera of Chest.—Right lung, lower lobe, very much engorged, with some semi-organ plastic lymph over lower border, also some engorgement of posterior middle lobe; upper and left lung healthy.

Pericardium natural. No effusion in cavity. Heart increased in size about one- Endocardium healthy. Each cavity contained a firm, fibrous clot, in size corresponding their capacities, and closely interwoven with the mitral and tricuspid valves; veins emp into heart full of fluid blood.

Brain and Membranes.—A slight cloudiness of the arachnoid, with three small, opaque sp well defined, of the same membrane, on the upper portion of the left cerebral hemisphere. the removal of the brain, about three ounces of blood escaped. No effusion in the ventri Cohesive power of tissue natural; color natural. Blood congested in the veins.

Remarks.—The information obtained in the examination of Thompson is both positive and negative. Negative, in that no organic lesion was detected that can account satisfactorily for the destruction of life. But slight information based upon positive phenomena w detected, and they produced no symptoms during life to diagnose their existence. We ha positive information of great congestion of the liver and spleen. In the liver it is so great that the cohesive power of its tissue is greatly destroyed, and, when torn, bleeds freely dark, venous blood, indicating excessive engorgement in connection with its increased si and the corresponding augmentation of the spleen may account for the deficient capillary cir culation, as well as the systemic circulation. The heart thus robbed of a portion of its accustomed stimulant, must be correspondingly weakened in its action, which, in its turn cause and effect, must add negatively to the coldness of the surface and defective circulation in the extremities. In the congested condition of the liver and spleen, they act as a re for the circulation, which, penned up in the carbonized state, must, (if the theory of nervous action be true), produce the toxical effect of carbonized blood on the brain.

In this we have a solution of the delirium, so common in these cases, and also the ing and irregular breathing, and in some cases the congestion of the lungs, the result of impaired action of the pneumogastric nerve in the carbonized state of the brain.

This condition lasting any considerable length of time, the nervous system is nec overpowered, and as power fails, co-existing with the congested state producing it, des tion of life must be the result, notwithstanding no organic lesion may be detected suffi account for it. One of the functions of the liver, the secretion of bile, was still in action, shown by the full gall-bladder—no organic lesion existing, though greatly congested, cient to prevent it from performing its highest function.

What agency, if any, did the heart clots have in this case? One interesting feature in this case, and present in all the others, was the pulseless condition of the extremities so early in the case, even before the strength of the muscular system had failed enough to prevent rising and walking about in their huts. One of the cases I found pulseless when I first called to see him, standing up by his fire, his comrades and himself alike ignorant of his danger. May not these clots begin to form during the chill, under the powerful nervous depression and congestion then existing, aided by the poisonous effect of the morbific agent in the fountain of life, changing its chemical and reciprocal affinities? These clots are said to form mainly in death, and occupy the right side of the heart, but in this case, every chamber had its corresponding clot. May not their occupancy of the heart, obstructing the circulation, account for the constant failure of stimulants to arouse it, or increase its force when feeble and failing?

The condition of the brain and its membranes was not incompatible with mental action or life, not congested enough to destroy its functions, and very little evidence of inflammation, the slight opacity of the arachnoid being its only indication, and it gave rise to no symptoms of its existence.

Surgeon Jelks, of the 26th Georgia, assisted me in the examination, and informs me that he lost six cases in his regiment last winter, while stationed on the sea coast of Georgia, quite similar in general symptoms, duration and fatality. Of these he made two post-mortem examinations, and found the same condition in both cases. One of the cases was placed in hospital, and treated by Prof. Byrd, of Savannah, Ga., who assisted in the examination of the case placed under his care. In both of these cases Surgeon Jeiks informs me, that the symptoms indicated the brain and its membranes as the chief source of trouble, both cases were so diagnosed, the first by Surgeon Jelks, the second by Surgeon Byrd. In the examination, less morbid action of the brain existed than in the case of Thompson, but, like his, presented excessive engorgement of the liver and spleen.

All the cases in my regiment, so far as I can obtain definite information of others, have been stout and healthy, with little or no premonitory symptoms warning them of their danger.

What is the true nature of this disease? I do not believe that any visceral lesion occurs in these cases sufficient to account for its fearful destruction of life, though future investigation may exhibit a constancy in morbid changes.

It cannot be Cerebritis or Cerebro-Spinal Meningitis. In the case of Thompson the lesion was not sufficient; nor are the symptoms of its existence constant, in some cases no evidence of undue action exists, and when they do exist, as in the cases of Surgeon Jelks, no lesion was recognized by the scalpel. So too, the duration, symptoms and post-mortem phenomena forbid the idea of Typhus.

From a close study of the cases that have fallen under my care, the course which one of them ran, the association of the disease, and the result of the examination, (abundant in itself, though needing repetition to give the evidence required for consistency), I am of the opinion that the disease is a severe, aggravated form of congestion or Pernicious Fever.

The case referred to above is the fourth case of this disease occurring in my regiment. His case lasted long enough to give some idea of the type. His chill came on in the evening, lasting forty or fifty minutes, and was followed by a paroxysm of fever of ten or twelve hours' duration; then came a complete intermission, in short, an exact type of Intermittent Fever; in the intermission he walked about camp.

His second chill came on at the same time, on the third day, same duration as the first, same peculiar pain on one side of the face, but more intense. The chill was followed by a little reaction of a few moments, when his pulse began to sink; in one hour the pulse was extinct, and the patient died at the end of three or four hours from the appearance of the chill.

Remittent and Intermittent Fever have been common in my regiment all the winter; an intermittent type has been prevalent in nearly all cases of Diarrhœa, Dysentery and Influenza. Our intermittents have been well marked, generally mild, and yielding kindly to treatment. In the last ten days they have increased in severity. Only one peculiarity has presented itself in this disease—the majority of chills coming on during the night time. The pain in these cases is in many respects like that of Dengue, but dissimilar in everything else. The post-mortem appearances of the liver and spleen are not new features in the course of Intermittent and Remittent Fevers, and I feel quite certain that the fatality of the Congestive or Pernicious Fevers, would be equally as great under similar circumstances.

But a devotee to a perfect malarial theory, may object to this conclusion, on the ground that malaria cannot exist on the snow-clad hills of our camps, so destitute of warmth, one of the essentials for its production. My reply is—may be the nature essentially productive, and modus operandi of this theoretical entity are yet unknown, and that facts should not be laid aside because thereof.

The blood exhibited signs of disorganization in all the cases I have seen, by the purpura, several hours before death, in cases lasting ten or twelve hours. The purpura is evidently the disorganized blood in the sub-cutaneous tissue, and it may be that this disease-producing element is a blood poison of some kind, like that of Scarlet Fever, Small-Pox, Diptheria, Cholera, etc., which, when imbibed sufficiently overwhelms the nervous system, changing the chemical and reciprocal affinities and tissues, and ending in the phenomena presented by these cases.

I am, sir, very respectfully, your obedient servant,

J. T. BANKS,

Surgeon, Thirteenth Regiment, Georgia Vols.

Report on the Preceding Papers, by Surgeon R. J. Breckenridge, Inspector of Camps and Hospitals, Army of Northern Virginia.

Office Medical Director Army of Northern Virginia,
August 14th, 1863.

Surgeon L. Guild, Medical Director Army of Northern Virginia:

Sir.—Having carefully considered the papers referred to me, from Surgeon Mitchell, Sen. Surgeon Rhodes' Brigade, Surgeon Banks, Thirteenth Ga., Surgeon P. G. Robinson, Twenty-second N. C. Regiment, bearing date, respectively, February 21st, March 28th, and April, 1863, all relative to a certain form of disease deemed worthy of special mention,—I respectfully return them, with the subjoined brief analysis of their contents, with my opinion of the real nature of the cases reported.

This opinion, it is proper to add, was originally written on Surgeon Mitchell's paper submitted to me by Surgeon McGuire, some months ago, and now made the basis of this report—and not upon a personal examination of any case, which, though anxiously sought by me, was unattainable, owing to the fact, 1st, namely, that none of these officers reported these cases, until they had nearly, if not altogether, ceased occurring; and, 2d, that the most sharply defined of these appeared to be too rapid in their progress to admit of the visit of Surgeons at all remote from the scene of their occurrence.

The correctness of this opinion is not, to my mind, at all impaired by Surgeon Banks' paper, which is most strikingly confirmed by that of Surgeon Robinson.

Surgeon Mitchell had 8 cases, 6 of which were fatal, but he reports only one—that as the type of them all. Surgeon Banks does not state the number of his, nor their relative mortality, but gives a history of Case No. 5, as typical. Surgeon Robinson had four cases, three of which were fatal. The case reported in detail was the least grave in its objective features, but furnished, upon post-mortem examination, evidences as clear, though not so great, of its true pathology, as the two others examined. It is greatly to be regretted, whatever may be the reason, that these examinations are so seldom made in the army.

Surgeon Mitchell's conclusion is that these cases are essentially typhus in their nature. Surgeon Banks thinks his belongs to the class of "Pernicious or Congestive Fevers," though I do not perceive the force of his reasoning, and cannot acknowledge that his conclusions are justified by his own statement of the symptoms observed and pathological appearances noted.

Surgeon Robinson's cases are demonstrably cases of Cerebro-Spinal Meningitis, as shown by the scalpel. My conviction, however, is that but little importance is to be attached to the idea of any family tendency, evidently entertained by him, as a remote cause of this disease.

Calling your attention to the paper of Surgeon Mitchell, with its endorsement, to the paper of Surgeon Banks, which is a special plea for the recognition of the disease as "Pernicious Fever," though his own cadaveric section fully recognizes the co-existent inflammation of the cerebral meninges, while the condition of the spinal is not even reported examined, and to the close analogy of symptoms in some respects, in his cases, to those belonging to undoubted cerebro-spinal inflammation on the one hand, and Surgeon Mitchell's cases on the other;—and finally to the extraordinary corroboration of my views recorded last March, by the result of Surgeon Robinson's post-mortem examinations, in all of which notable evidences of the existence of this disease were found, I submit the following extract from my response to Surgeon McGuire's endorsement upon Surgeon Mitchell's report, referring it to me for an expression of my professional opinion upon the cases therein reported, as a statement of my views upon this most interesting subject, repeating that they deserve farther consideration than may be attached to a discussion based alone upon written reports, and not personal examination.

* * 3d. I think Dr. Mitchell is right in considering this disease either a Cerebro-Spinal Meningitis, or, on the other hand, an essential typhus.

As it has come under his observation, it is either epidemic or contagious, or both. So is Typhus. It is rapid in its progress, more so than Typhus generally is. It seems to have been attended by more spasms and convulsions than usually belong to Typhus. While, on the other hand, the spotted appearance of the skin, (undoubtedly I suppose the result of an effusion of disorganized blood), presents a marked likeness to some cases of Typhus, and goes very strongly to uphold their identity, still, as you justly remark, many of the symptoms are wanting, so many that I am forced to this conclusion, either that this is a new form of "blood-poisoning," or that it is Cerebro-Spinal Meningitis.

Let me now give you my reasons for believing it to be the latter:

1st. Cerebro-Spinal Meningitis, though an active and violent inflammation (more particularly of the Arachnoid,) yet has these features in common with Dr. Mitchell's cases.

a. It is epidemic at times. No less than three epidemics are recorded in France, Ireland, and Gibraltar.

b. It is extremely rapid in its termination, in its epidemic form, as will be seen below, and it is fearfully fatal.

2d. There is a coincidence most remarkable, in all respects in symptoms. The notable difference in epidemics, generally being that the disease rarely attacks persons after puberty. Yet Dr. Gilkrist in his account of the epidemic at Gibraltar, admits that a few over the age of thirty were severely attacked; but on the other hand, the disease in France, attacked mainly "Conscripts who had lately joined their Regiment."

3d. Now for the symptoms. The symptoms by which the disease commences are in general of a very formidable character, and its accession is usually sudden, and quite unexpected; in the majority of cases, the patient was in his ordinary health and spirits, up to the very moment of seizure, and had experienced no premonitory symptoms to warn him of his danger. In four of the cases in the South Dublin Union, the boys had eaten a hearty dinner, and retired to bed in apparent health, when the disease all at once declared itself. In many instances it commences with severe pain in the abdomen, followed immediately by vomiting, and not unfrequently by purging. In the worst cases, the symptoms are accompanied by marked collapse, the extremities are cold and bluish, the pulse is at this time a mere thread, and altogether the disease assumes very much the aspect of Cholera. After the lapse of a few hours, reaction, more or less perfect ensues, the muscular system then presents characters which may be considered almost pathognomonic. The muscles of the extremities, and those of the neck in particular, become remarkably rigid, the head is drawn back upon the vertebral column, and finally fixed in that unnatural position; no efforts of the patient can bend it forward, neither can the attendants do so, at least by the employment of any justifiable force.

The countenance at this period, often assumes very much the tetanic expression; twitchings of the muscles of the face sometimes ensue, the patient loses in great measure, the power of moving his extremities, so that he is quite unable to assume the erect position; the surface becomes hot, the pulse feeble and frequent, from 120 to 140, the stomach often continues irritable whilst an insatiable thirst torments the sufferers, and the epigastrium evinces marked tenderness upon pressure.

Symptoms of a still more serious nature quickly supervene; the patient may be seized with general convulsions of a frightful severity, requiring personal retainment, to prevent him from injury, or he may be in a semi-comatose condition, constantly moaning and grinding his teeth, or even crying incessantly. Towards the close of his sufferings, he generally merges into perfect coma, the pulse becomes slow and labored, the powers of speech and deglutition fail, his stools are passed involuntarily, and death finally closes the scene. All this may occur in a surprisingly short space of time; some of the cases ran their course in forty-eight hours and the greater number terminated about the fourth day, whilst some few were prolonged even to a fortnight, or three weeks. Examples are on record of death from the disease in as short a period as fifteen hours. Fatality in France, 80 per cent. The only statistics before me give: army soldiers, 195 cases, 122 deaths; not stated, 194 cases, 40 deaths; civilians, 450 cases, and 20 deaths.

I do not see that the fact of there being "blood-poisoning," at all interferes with the idea of active, or even distinctive inflammation. Witness genuine Typhoid Pneumonia, or the inflammatory ulceration of Typhoid fever, etc., etc. I suppose the truth to be, that it is not a symptomatic fever, i. e. Cerebro-Spinal Meningitis followed by fever—but essentially Idiopathic, i. e. Cerebro-Spinal Meningeal Fever—an Idiopathic fever, (dependent if you please upon serious lesions of the blood primarily,) the brunt of which is borne by the Cerebro-Spinal Arachnoid, like the glands of peyer in Typhoid, or the joints and heart in Rheumatism.

I am sir, very respectfully, your obedient servant,

R. J. BRECKENRIDGE,
Surgeon and Inspector of Camps and Hospitals,
Army of Northern Virginia.

Dr Robinson published an account of the four cases of Cerebro-Spinal Meningitis recorded in his report of sick and wounded in 10 Companies, 22d North Carolina Regiment, previously given in the Confederate States Medical and Surgical Journal, Vol. No. 2, February 1865, p. 33. The published account did not differ in any essential respect from the official report.

The following article by Surgeon G. A. Moses, of Mobile, Alabama, together with the matter presented in this chapter, includes, as far as my information extends, everything contributed by the Confederate Surgeons, on the subject of Cerebro-Spinal Meningitis, during the progress of the American Civil War.

Epidemic Cerebro-Spinal Meningitis, by Surgeon G. A. Moses, Mobile, Alabama.

During my connection with the Army, my attention has been at various times, attracted by a disease which had hitherto never come under my observation. It is that type of Cerebral disease, known as Cerebro-Spinal Meningitis. It occurred I believe at Bowling Green, during the winter of 1861–1862.

In the succeeding winter, while the Army in the West, was at Grenada, Miss., this disease made its appearance among the negroes employed upon the fortifications, and also among plantation hands, in several adjoining counties. Again during the past winter, I have observed it at this place, almost entirely confined to the blacks, both those employed by Government, and others. Some cases have occurred amongst the citizens, principally in children. The disease is marked by its rapid course, and fearfully frequent termination. I have heard of but few *reported* recoveries, and have seen none.

The first account* I find of a disease resembling this, but unnamed, dates in 1310, when it appeared in France; it is not again mentioned until 1503. A disease almost similar appeared in 1510 and 1517; after a very severe winter, (1553) in Silesia, it carried off large numbers of the population In 1580, associated as now with Catarrhal affections, it killed no less than 10,000 persons in Rome, 12,000 in Madrid, and proportionally large numbers in other cities. During the Civil Wars in France, 1616, Ozenaur says, "The armies both Catholic and Protestant, are decimated by a new disease," the subjects being attacked by "sudden and fearful pain in the head." It lasted more than three months, and but few were saved. Sydenham reports it in 1661 and 1664, as selecting the young and most robust subjects and as partaking of the type of Typhus. In 1788, during an epidemic of Typhus in Lyle, a disease appeared more nearly approaching to the character of the present epidemic. It was accompanied with tetanic convulsions and coma, the pia-mater being chiefly involved. Not until 1830, was the name given to this disease, when upon closer examination, were more fully vindicated its seat and nature. Of late years, it has occurred in many portions of the Confederacy. No sufficient cause has yet been assigned for its appearance or cessation.

M. Toudes, in his valuable paper, has published statistics of attributable causes, and assigns the abuse of alcoholic stimulants as the chief—but of 136 cases quoted, in 100 cases the cause is "*unknown.*"

As it has occurred in the Army, it cannot be attributed to alcohol, as amongst its victims this stimulant could but rarely be obtained. It appears generally, if not universally, during cold, wet winters, along with severe types of pulmonary complaints, and passes through the stages of all serous inflammations.

It is remarkable for the suddenness of its declaration, its rapid development and termination. The subjects generally the young and most robust, are to all appearance in good health; a chill, or pain in the head, first attract attention; in a very few hours the patient grows stupid, pain in the head appears to concentrate about the base, the neck becomes stiff, pains are felt in the extremities, or in the abdomen.

These signs increase until the muscles of the neck and back become rapidly contracted giving almost opisthotonos; the smallest movement of a finger or toe, is attended with intense pain; the pupil of one or both eyes is dilated or inactive, or their action is reversed; coma occurs, often trismus; the tongue until now moist and normal in color, or, as is more usual, covered with a whitish fur, becomes dry, hard and swollen; bowels obstinately constipated, pulse small and slow, respiration labored, profuse diaphoresis, and in a short time death closes the scene, or the patient may have an intermission of the severe symptoms for twelve or twenty-four hours, the physician may hope until suddenly a relapse takes place, with fatal ending.

Treatment has been of but little benefit—everything has been recommended and tried, with poor success.

M. Rollet advised general blood-letting, leeches and cups to length of spinal column, the actual cautery, with sinapisms, and blisters of Ammonia, covering the whole body. Grisolle, in addition, recommends Mercury, Ganssauch trusts to Quinine, Chauffard to Opium in large doses. They all lost from sixty to eighty per cent. of the cases. After the disease has gressed to the extent it may in four or six hours, no medicine appears to act, Croton Oil failing to move the bowels to action.

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*Vid. History of Epidemic, Cerebro-Spinal Meningitis: Bibliotéque du Médecin Practicien, Vol. ix.

The first symptom of the disease, which attracts attention, appears generally to indicate not the commencement of disease, but its maturity, as in those cases which die in from ten to fifteen hours, with large effusion of lymph in the pia-mater. Insidious in approach, it declares itself at a time when interference is of no avail.

I am indebted to Dr. S. C. Young, P. A. C. S., for information regarding the course of this disease at Grenada, Miss. Of thirty-five cases which came under his observation, he *knows* of no recovery; one was apparently improving, when at the end of the third week, he was taken from the hospital, some of the cases under his charge, lived twelve and fifteen days, even longer. He thinks mercurials and stimulants promise the most success. Theory would seem to approve his opinion, but the great difficulty is to bring the patient under the influence of the remedy. The disease as it has appeared in hospital here, runs its course with more uniform rapidity than it has before done, no case having lived through the fifth day.

Like Cholera and Yellow-Fever, this epidemic appears to depend on a specific poison, excited by certain changes in the atmosphere. Experience has not advanced our knowledge of the real cause or treatment of this most fatal disease, selecting as it does the hardiest subjects in the flush of strength and life, it baffles all our skill.

The accompanying notes in several cases which are types of all the others, will sufficiently exhibit the symptoms, treatment, termination and pathological appearances.

The only change in the blood is an increase of the fibrin.

The cerebellum is more often and seriously affected than the cerebrum, being sometimes softened, in its superficies, while the internal portion has a reddened appearance, the puncta vasculosa seeming larger and more numerous. This I judge to be a secondary complication. The pia-mater is the membrane in which the disease finds its origin, and generally exhausts its course.

NOTES OF CASES. CASE 493.—March 24th, Alick, slave, aged about twenty-five years, entered hospital at 10 A. M.; has felt unwell since yesterday; quit work in evening. This morning condition as follows: Pulse 64, soft, compressible and small; tongue moist, of good color, excepting a little whitish fur in the centre; countenance natural; left lung congested, a little crepitus; some rigidity of posterior cervical muscles; bowels constipated. Prescribed Hydrarg: Chloride: Mit: pulv. Jalapæ aa grs. x., wet cups to chest; cold douche to head to be applied continuously for half an hour, and intermitted for some length of time, and so alternately during day; whiskey 1 drachm, every half hour, as long as necessary to produce effect. 5 P. M.; Pulse 80, very irregular, soft and quick; respiration 28; has been noisily delirious and difficult to restrain in bed, since 1 P. M. pupils largely dilated and inactive; passing urine involuntarily; spit out purgative this morning; skin of natural heat; cries as though suffering; continue whiskey and douche.

March 25th, 9 A. M.—Pulse 94, small, soft and regular; respiration quiet and easy at 28; pupils contracted to a very small size and inactive; deep coma; left side of face warm, right side cool. Body and extremities warm; diaphoresis; tongue dry, continned whiskey as often as could be administered. 4 P. M.—Pulse 110, fuller and soft; left pupil acting a little less promptly than normally; right pupil still contracted and motionless; face and skin same as this morning—not so much perspiration. Continued whiskey. 6 P. M.—No change except that respiration is somewhat quicker.

March 26th.—Died at 6½ A. M.; *Autopsy* at 4 P. M.; body still unusually warm, although weather is cold; dura-mater healthy; on taking off this, the arachnoid is seen transparent, except when underlaid by lymph deposit; blood-vessels much congested and very tortuous; each vessel carries in its track lymph, more anteriorly than posteriorly; base of brain a mass of lymph, with some pus about the optic commissure, across and around the pons varolii and medulla oblongata; arachnoid in some places bound down by bands of lymph; the deposit enters the convolations, along with the pia-mater; lateral ventricles contain turbid serum, with flakes of lymph. Spinal cord posteriorly covered with same lymph deposit.

CASE 494, March 10th.—Henry, slave, age 25; entered hospital March 29th, 9 P. M. Complained from the first of pain in the head, so intense that he constantly emitted cries and groans; pulse weak, at about 90; tongue moist and white; pupils slow to act; had a chill before entering hospital.

March 11th.—Pain increased, no change otherwise; is taking 5 grains Iodide of Potassium every hour. 12 M.—So noisy that he was moved to a detached room; seems to be suffering intensely; still conscious, but no answers can be elicited. 4 P. M. Pulse somewhat increased in frequency; tongue dry; pupils dilated and almost inactive; coma commencing. 13th, 10 A. M.—completely comatose; skin moist and cool; perfectly quiet; lying on the back for the first time; muscles of neck rather stiff; scalp blistered last night, and stimulants administered; pulse slow and feeble.

March 14th.—Died at 4 A. M.; Autopsy at 10; usual appearance of congestion and lymph deposit around arachnoid and pia-mater; pacchionian bodies enlarged; Large deposit of lymph and pus at base of brain, especially over pons varolii and medulla oblongata; substance of cerebellum reddened and slightly softened superficially.

CASE 495.—March 19th, 5 o'clock P. M.; John, slave, age 28; has been sick for [illegible] before entering hospital, with Diarrhœa; operations large and frequent; has taken [illegible] grains of Opium.

March 20th, 9 o'clock A. M.—Bowels quiet, and moved since last evening; pulse [illegible] and soft; temperature of skin natural; inclined to be stupid; tongue dry and covered in centre with a white fur; pupils much contracted and motionless; complains of pain in head and neck, and in extremities, especially in superior; ordered whiskey, ½ ounce every hour. Died at half past four this afternoon. Autopsy: Dura-mater, in several places near pacchionian bodies, adhered to subjacent membrane, so that in uncovering the brain portions of it were separated, leaving small, smooth, irregular cavities, as of a slough; lymph deposited along course of blood-vessels, and posterior to optic commissure; no disease in spinal cord.

CASE 496.—Reported by Assistant Surgeon J. H. Purifoy. Entered February [illegible], with some symptoms of Pneumonia, which endured for a day, before signs of Meningitis occurred, when the case took the usual course of the above-mentioned cases, with one marked peculiarity:

The pupils, after being dilated, became much contracted, and *expanded upon the admission of light.* Death occurred on the fifth day. Post-mortem examination revealed: enlargement and an appearance of red hepatization of the pituitary body, in addition to the usual deposition of lymph, with some pus. This case was treated throughout with Quinine and stimulants, after bleeding by cups to the extent of ten ounces.—Confederate States Medical and Surgical Journal, Richmond, August, 1864, vol. i, No. 8, pp. 113-115.

After the close of the war, articles and observations on Cerebro-Spinal Meningitis were published by several Southern physicians, as Prof. E. S. Gaillard, M. D., Richmond Medical Journal, Vol. 1, No. 3, pp. 204–212, March, 1866; William O'[illegible], M. D., of Marion, Ga., Atlanta Medical and Surgical Journal, Vol. 8, No. 1, pp. [illegible]–18, March, 1867; James S. Dyer, M. D., of Hartsville, Tennessee, Nashville Journal of Medicine and Surgery, June, 1867, pp. 472–478; Prof. Juriah Harris, M. D., of Savannah, Georgia, Savannah Journal of Medicine, July, 1866, p. 219; H. M. [illegible], M. D., of Cuthbert, Ga., Med. and Sur. Reporter, August 11th, 1866, p. 141; W. [illegible] Armstrong, M. D., of Atlanta, Ga., Atlanta Medical and Surgical Journal, June, 18[illegible], vol. vii, No. 4, pp. 145–151; W. C. Moore, M. D., of Atlanta, Ga., Atlanta Medical and Surgical Journal, January, 1867, p. 491; W. O. Baldwin, M. D., of Montgomery, Alabama, Am. Jour. Med. Sci., Oct., 1866, pp. 321–338; J. W. Moorman, M. D., of Hardingsburg, Ky., Am. Jour. Med. Sci., Oct., 1866, p. 336; J. H. Southall, M. D., of Little Rock, Ark., Rich. and Louisville Medical Journal, Aug., 1872, p. 138; John L. Cook, M. D., Elizabethtown, Ky., Rich. and Louis. Med. Jour., Nov., 1872, p. 5[illegible]; J. A. Larrabee, M. D., Louisville, Kentucky. Rich. and Louis. Med. Jour., Dec., 187[illegible], p. 764.

In like manner, various Northern and Western physicians have contributed to the history of Cerebro-Spinal Meningitis during and subsequent to the recent war, as [illegible] H. Draper, Am. Med. Times, Aug. and Sept., 1864. W. W. Gerhard, Am. Jour. Med. Sci., July, 1863; J. B. Upham, Boston Medical and Surgical Journal, 18[illegible], and Sept. 3d, 1874; J. S. Jewell, of Chicago, Report made to the Illinois State Medical Society, June, 1866; Chicago, 1866; S. G. Webber, Boylston Prize Essay, 18[illegible], reprinted from Boston Medical and Surgical Journal, 1866; L. Parks, Report of [illegible] Committee of the Massachusetts Medical Society, May, 1866, Boston, 1867; J. [illegible] Levick, Trans. Am. Med. Ass., vol. xvii, 1866; Stillé, Philadelphia, 1867; [illegible] Am. Jour. Med. Sci., July, 1867.

The facts recorded by these and other observers, will be considered under the appropriate divisions of this investigation.

Dr. S. G. Webber, in his Essay, which received the Boylston Medical Prize, has recorded the following facts with reference to the prevalence of Cerebro-Spinal Meningitis in the Northern Army and States. The earliest records of the late epidemic were during the winter of 1861–2, when it was seen in the Army of the Potomac, and in Livingston County, Ind. In the fall of 1862, it appeared among the negroes who were taken to Memphis, Tenn., by the Union army, and one or two cases were [illegible] ong the Union soldiers in the vicinity of Newbern, N. C., during the winter of 3, and spring of '63, it appeared in La Grange County, and other portions of n Indiana, at Newbern, N. C., during January, February and March, and these months, and also April, at Newport, R. I., among the Midshipmen at the Academy; in February and March it was seen at Philadelphia, and during the art of the year at Cambridge, Ohio. During the two successive winters of 3 and 1863–64, it was epidemic in Morgan County, Ill. The year in which bber found the largest number of accounts of this epidemic was 1864. During ter of 1863–64, the negroes of Memphis were again visited by it, and during e winter and succeeding spring, Darwin, in the southern part of Clark County, rk, in the Northern part of Crawford County, Ill.; in the northwestern part of lvania, and parts of New Jersey it was noticed during this year, and also in nd 1863; only a few cases occurred around New York. During January it Brattleboro, Vt., during January and February in Philadelphia, and at Benton s, near St. Louis, Mo. During March it was seen in Brandon and St. Albans, Louisville, Ky., and during January, April and March, cases were seen in Mass.; during May, at Chicago, at Leland, and in Williamson County, Ills.; the last part of July, three cases occurred at the Stanton General Hospital, gton, D. C. In October, Mechanicsburg was visited by it, and in November, l, Ill., and during the latter part of the year, St. Pauls, Ind. During the winter –65 a few cases were seen at the City Hospital, Boston; in January, 1865, at ich, and in April at Palmer, Mass.; in the latter month at Kewana, Fulton , Ind., and early in the year at Palestine, near Indianapolis, Ind.; in May, at Hall, Penn. From September, 1864, to May, 1865, this disease appeared the troops on Gallops Island, Boston Harbor, Mass.; cases occurred in Boston 6.—Boston Medical and Surgical Journal, vol. lxxv, pp. 183, 184. In Phila- the epidemic appeared in 1863, and renewed its appearance annually up to During the same period it prevailed in certain parts of Maryland, Virginia, Carolina and other Southern States. In Massachusetts the disease appeared 1870, and the number of cases rapidly increased, until they culminated in the at extensive epidemic of 1873.—J. B. Upham, M. D., Boston; Med. and Surg. Sept. 3d, 1874, p. 222.

g the winter of 1872 and Spring of 1873, Cerebro-Spinal Meningitis, (Epidemic itis), prevailed in New Orleans to such an extent as to attract some degree of ; 79 whites and 41 colored (total 120), having fallen victims to this disease x months ending June 1st, 1873. During this epidemic I repeated the obser- which I had made upon this disease during the civil war of 1861–1865, and ed the conclusions which I had previously adopted, viz: that

Cerebro-Spinal Meningitis is characterized by true *inflammatory symptoms*, crease of fibrin in the blood, elevation of temperature, derangement of digestion eration of nervous and muscular phenomena. Unlike the true fevers, the blood ged with fibrin, and fibrinous deposits are found within and around the inflamed es of the brain.

Post-mortem examinations in New Orleans confirmed my previous view, that ease consists essentially of an inflammation of the arachnoid and pia-mater of the nd spinal cord, and that in some cases the structures of the cerebro-spinal cen- y be involved in the inflammation.

The fatality attending this disease must be referred to the character of the involved, and also to the destructive effects caused by the pressure of the coagu- ymph and effusion within the unresisting, bony cavity of the cranium and spinal

The onset of the disease is in most cases sudden, and characterized by chills y sensation, intense and excruciating pain in the head, and in the back and of the lower extremities; vomiting; oppressed and labored respiration, irregular, feeble pulse, convulsive, muscular movements, jactitation, hyperæsthesia, delirium and opisthotonos.

5th. The duration of the disease is not governed by fixed laws, as in the idiopathic fevers, as Small-Pox, Varioloid, Measles, Scarlet Fever, and Typhus and Typhoid Fevers, but is governed by the nature and extent of the primary and secondary local lesions. In cases in which the brain and spinal cord are greatly congested, the fatal issue may occur in a few hours, from deficient and perverted nervous supplies, and arrest of respiration from the profound lesions of the medulla oblongata. Many cases may continue for weeks and even months, manifesting various disturbances of the nervous and muscular systems, attended with daily elevations and depressions of temperature, as in Typhoid Fever and Hospital Gangrene, and finally terminate fatally.

6th. It results, from the nature of the lesions in Cerebro-Spinal Meningitis, not only that the disease may be of indefinite duration, but also that recovery in some cases is more to be dreaded than death itself.

The following case, illustrating the preceding statement, came under my observation during the prosecution of my investigations upon this disease, in 1872 and 1873:

Case 497: Illustrating the Permanent and Disastrous Effects which may result from Inflammation of the Meninges of the Brain and Spinal Cord.

Charles Smith, age 21, native of Vicksburg, Miss, mulatto. He is said to have been a healthy child at the time of his birth, and remained so until he had attained the age of nine months, at which time he was seized with violent convulsions, dependent apparently upon inflammation of the base of the brain and spinal cord. The effects of this disease were complete paralysis of the arms and legs, rigidity of the spine, paralysis of the tongue, and arrest of mental development. The head and trunk of Charles Smith have attained the size of those of a man, whilst the arms and legs are withered, contracted, contorted, and utterly useless, and powerless. Up to the present time, Charles Smith has remained utterly helpless, and emits only weak, inarticulate sounds. During the past 20 years, he has remained more helpless than an infant, and is one of the most afflicted and pitiable objects that I have ever seen.

If Cerebro-Spinal Meningitis be related to the membranes of the brain, as Pleuritis is to the investing membrane of the lungs, it should be classed with the *phlegmasiæ*, in which there is an actual increase of the fibrin, and not with the pyrexiæ, in which this element is deficient; and in the character of the lesions of the cerebro-spinal system, we have an explanation of that striking and important fact, that amidst a marked uniformity of symptoms in different cases, and in different epidemics, in various countries, and at various times, the duration of the disease is as indefinite as that of Pleuritis or Pericarditis.

CHAPTER VII.

NATURAL HISTORY OF CEREBRO-SPINAL MENINGITIS. CHANGES OF TEMPERATURE, PULSE AND RESPIRATION. PATHOLOGICAL ANATOMY OF CEREBRO-SPINAL MENINGITIS.

PULSE.

Every variety of pulse has been observed in the same epidemic, and even in the same patient.

In cases which run a rapid course to a fatal issue, as a general rule, the pulse is small, weak, thready, and intermittent, increasing in frequency until nothing but a tremulous motion is felt.

In some cases it is full, tense and slow, and the frequency of the pulse is not a prominent symptom of the disease; in others its rate and volume are subject to repeated variations, sometimes rising, during the course of a few hours, from 30 in a minute to 130, and changing in the course of an hour, and even in less time, from quick to slow, and from strong to feeble, and vice versa.

Any slight exertion, as rising from the recumbent to the sitting posture in bed, may double its frequency, and render it irregular.

It is evident, from the preceding facts and observations, that it is impossible to establish a rule for the variation of the pulse in frequency and force, as we may do in certain diseases, as Yellow Fever; on the other hand, the diminution of force and volume, and the impairment of its tone to such a degree that slight causes produce extreme variations in its rate and rythm, indicating great diminution of the powers of the heart, are characteristic qualities of the pulse in Cerebro-Spinal Meningitis, and distinguish this disease from the essential fevers.

The enfeeblement and irregular action of the general capillary circulation in Cerebro-Spinal Meningitis, is directly referable, not to a poison in the blood, but to the effects of the characteristic meningeal inflammation with its attendant congestion and effusion upon the vaso-motor and respiratory nervous centres of the brain, medulla oblongata and spinal cord. No extended discussion of this subject is needed in support of the preceding proposition, as the relations of the circulation and respiration to the cerebro-spinal and sympathetic nervous systems have been considered in the first, third and fourth chapters of this work.

RESPIRATION.

As a general rule, the respiration is embarrassed in relation to the gravity of the case, and the extent and position of the meningeal inflammation and fibrinous effusion. As in the case of the pulse, the respiration may be rapid or slow, without reference to the other symptoms; in general it is difficult, sighing, labored and interrupted, the *inspiration* especially being laborious and prolonged. The disturbances of respiration are to be referred to the same general causes as those of the capillary and general circulation, viz: to the involvement of the respiratory ganglionic centres, either directly or secondarily, by the pressure upon the base of the brain, medulla oblongata and spinal cord, induced by congestion and effusion. There are no facts to show that the respiratory changes are caused by the presence of a specific poison in the blood.

TEMPERATURE.

In all the cases of Cerebro-Spinal Meningitis which I have observed, the temperature is elevated above the normal standard, and is subject to diurnal variations, and in some cases attained the degree of 107 F. In many cases, however, which recover, and even in fatal cases, the temperature does not attain the high degrees which are characteristic of certain diseases, as Typhus, and Typhoid, and Yellow Fever, and Small Pox.

In the following fatal case, the temperature never exceeded 103° F:

Case 498: Cerebro-Spinal Meningitis.

Thomas Runan, æt. 26, native of Ireland; entered Charity Hospital, Ward 13, February 14th, 1873. Comatose; neck and back stiff; opisthotonos. Under the use of purgatives, Quinine, Opium, Bromide of Potassium, and Chloroform applied over spine, the patient recovered sufficiently to sit up in the bed, but died suddenly in convulsions, February 26th, on the 12th day after entering my wards.

The temperature in the axilla ranged from 100° F, to 102° F.

In the following severe case of Cerebro-Spinal Meningitis, which recovered, the highest temperature observed in the axilla was 105° F.

Case 499: Cerebro-Spinal Meningitis.

Joseph White; occupation, hotel waiter, (St Charles Hotel); age 19; native of New York. Brought to Charity Hospital in a carriage a short time after complaining of being sick, January 4th, 1873. Whilst giving his name in the clerk's office, fell upon the floor in a violent convulsion. Entered Ward 13. I saw this patient shortly after his entrance; the convulsion was followed by delirium, and continual rolling of the body from right to left, the muscles of the neck and back being firmly contracted, and the head drawn backwards. Pupils greatly dilated. Pulse moderately accelerated. Temperature high, but subject to marked oscillations. The patient could not be kept in bed without mechanical restraint, on account of the constant rolling and twisting of the body from right to left. I had to confine him in bed, by high boards nailed to the bed-posts. A blister was applied to the back of the head, and over the superior portion of the spine, and the bowels, which were constipated, freely opened by Calomel; and Hydrate of Chloral, Bromide of Potassium, Quinine and Opium were freely administered internally. An effort was also made to bring the patient under the influence of Mercury by means of the following: ℞. Hydrargyri Subchloridi (Calomel), ℈i; Pulv. Ipecac et Opii (Pulv. Doveri), ℈iss; Quiniæ Sulph., ʒss; mix; divide into 10 powders; one powder every 4 hours. The preceding prescription was repeated several times during the active stages of the disease. On the 18th, the violent contortions of the body were somewhat mitigated, and the patient, although delirious, was able to complain (when aroused) of intense pain in the head.

Temperature, morning, 101°.1 F.; evening, 105°; pulse, morning, 70; evening, 104; respiration, morning 20; evening 32. Jan. 14th, patient more ratioaal, but still has opisthotonos and complains of intense pain in the head, and is occasionally delirious and turns in bed. Temperature of axilla, morning, 100° F.; pulse, 72; respiration, 24; temperature, evening, 105; pulse, 106; respiration, 30. Continue Calomel, Dover's Powder and Quinine. 15th, morning, temperature, 101°.8; pulse, 85; respiration, 21; evening, temperature, 104° F. 16th, morning, temperature 100°; pulse, 78; respiration, 20; evening, temperature, 103°.7; pulse, 68; respiration 20. 17th, patient says that he feels better this morning, and rested well during the night, still complains of some pain in the head. Temperature, morning, 98°.9; pulse, 90; respiration, 28; evening, temperature, 104°.9; pulse, 80; respiration, 28. 18th, continues to improve; morning, temperature, 98°.5; pulse, 80; respiration, 28; evening, temperature, 98°.5; pulse, 80; respiration, 24. 19th, patient complains of severe pain in head, and along the spine; there appears to have been some increase in the local inflammation, and this has been attended with a sudden rise of temperature, from 98°.5, on the evening of the 18th, to 104° F., on the morning of the 19th; the pulse also was increased to 100, and the respiration to 32. I repeated the compound of Calomel, Quinine and Dover's Powder, and rubbed Croton Oil over the spine. These measures appeared to be productive of good. The Hydrate of Chloral and Bromide of Potassium were also repeated, in doses varying from 20 to

30 grains of each, at intervals of from three to four hours. At 8 P. M., the temperature of the axilla had fallen to 101° F.; pulse, 84; respiration, 28. 20th, patient continues to improve; morning, temperature, 98°.3 F.; pulse, 84; respiration, 24; evening, temperature, 101°; pulse, 84; respiration 24. From this date the temperature fell to the normal standard, and exhibited slight diurnal oscillations; the patient gradually regained the use of the extremities, the muscles of the trunk and neck gradually relaxed, and he was discharged, cured, February 3d. The disease continued unabated for 16 days, and the patient was able to walk, and was fully restored to health on the 30th day. Throughout the disease I endeavored to maintain the strength, by milk punch and beef tea, and moderate quantities of alcoholic stimulants, administered at short and regular intervals.

The following table presents the oscillations of the temperature, and the pulse and respiration during 13 days—January 13th to 25th:

DATE.	DAYS OF DISEASE.	TEMPERATURE.		PULSE.		RESPIRATION.	
		Morning.	Evening.	Morning.	Evening.	Morning.	Evening.
January 13th, 1873,..........	8th.	101°.1 F.	105°	70	104	20	32
" 14th, "	9th.	100°	105°	72	106	24	32
" 15th, "	10th.	101.8	104	85		21	
" 16th, "	11th.	100	103.7	78	68	20	20
" 17th, "	12th.	98.9	104.9	90	80	28	28
" 18th, "	13th.	98.5	98.5	80	80	28	28
" 19th, "	14th.	104°	101°	100	84	32	28
" 20th, "	15th.	98.3	101°	89	84	24	24
" 21st, "	16th.	99.	99.6	84	80	28	24
" 22d, "	17th.	99.2	99.6	80	80	18	20
" 23d, "	18th.	99.2	99.2	80	88	18	19
" 24th, "	19th.	98.5	99.	84	84	18	18
" 25th, "	20th.	98.8	98.5	88	80	18	18

In the following case, the highest temperature was reached on the 15th day of the disease, when the thermometer in the axilla stood at 105.3. This marked rise in the temperature, as in the preceding case, was preceded by a great aggravation of the symptoms.

Case 500: Cerebro-Spinal Meningitis.

Peter Harwasen, age 50; native of Germany; entered Charity Hospital, Ward 13, January 20th, 1873, in a delirious state, with contraction of muscles of head and neck. Delirium, wild, requiring mechanical restraint; bowels obstinately constipated; pupils contracted. I caused the bowels to be freely opened with Calomel; applied a blister to the back of the head and neck; and administered internally at regular intervals, Hydrate of Chloral, Bromide of Potassium, and Quinine and Dover's Powder. The intellect was gradually restored and the contraction of the muscles gradually disappeared under these measures, and the patient was able to sit up in bed and converse on the 29th, 30th and 31st of January, and 1st of February. On the second of February he was seized with a chill in the morning, during which he became insensible, with cold extremities, and the temperature fell to 99° F. The chill was followed by high fever, the temperature of the axilla rising in the evening to 105.3 F. During the chill, and subsequent fever, the patient was entirely insensible; neck and back stiff; opisthotonos; respiration labored and puffing; pulse small, thready and irregular. The patient appeared to be in extremis. I repeated the blister to the back of the head and neck over the region of the spinal cord; and administered the combination of Calomel, Quinine, and Dover's Powder, as in the preceding case. During the period of great depression, I also gave freely Carbonate of Ammonia and Alcoholic stimulants. On the 3d, the symptoms were somewhat improved, and the patient gradually recovered consciousness, and progressed with slight oscillations of temperature, until the 11th, when there was a slight relapse, attended with a rise of temperature. From this date, the patient gradually improved and was discharged cured, March 10th, 1873.

The following table presents the changes of temperature during 21 days, January 25th to February 14th.

DATE.	DAY OF DISEASE.	TEMPERATURE.		DATE.	DAY OF DISEASE.	TEMPERATU
		Morning.	Evening.			Morning.
January 25, 1873..	5	103.2	103.5	Febr'y, 4, 1873...	15	98.5
" 26, " ..	6	102.4	103.2	" 5, " ...	16	96.1
" 27, " ..	7	102.7	101.4	" 6, " ...	17	97.3
" 28, " ..	8	103.	102.8	" 7, " ...	18	97.8
" 29, " ..	9	102.	103.	" 8, " ...	19	97.9
" 30, " ..	10	100.	102.	" 9, " ...	20	97.8
" 31, " ..	11	102.4	101.5	" 10, " ...	21	98.8
Febr'y 1, " ..	12	101.	101.2	" 11, " ...	22	98.7
" 2, " ..	13	99.	105.3	" 12, " ...	23	98.4
" 3, " ..	14	100.6	102.	" 13, " ...	24	99.7
				" 14, " ...	25	98.5

The following cases (501 and 502,) of Cerebro-Spinal Meningitis, treated in Charity Hospital, illustrate the daily oscillations of temperature.*

CASE 501. CEREBRO-SPINAL MENINGITIS.

John Tompkins, Age, 16 years.

DATE.	DAY OF FEV	TEMPERA.		PULSE.		RESP'N.	
		M.	E.	M.	E.	M.	E.
Dec. 26,'72	2	101.	103.2	88	100	18	.....
" 27, "	3	99.	103.5	62	64	.....	.....
" 28, "	4	100.2	101.5	82	92	.....	.....
" 29, "	5	99.8	102.5	101	100	.....	.....
" 30, "	6	101.5	102.8	105	100	.....	.....
" 31, "	7	103°	103.8	102	96	.....	.....
Jan. 1,'73	8	102.6	103.5	104	100	.....	.....
" 2, "	9	103.	102.6	104	108	.....	.....
" 3, "	10	102.	104.4	108	104	.....	.....
" 4, "	11	101.8	103.6	94	96	.....	.....
" 5, "	12	101.	104.	108	104	.....	.....
" 6, "	13	101.	105.	95	98	.....	.....
" 7, "	14	101.	103.5	110	108	.....	.....
" 8, "	15	102.	103.	98	90	.....	.....
" 9, "	16	100.4	100.	66	88	.....	.....
" 10, "	17	101.5	99.	94	86	.....	.....
" 11, "	18	98.5	103.	102	......	.....	.....
" 12, "	19	101.	102.	100	......	.....	.....
" 13, "	20	98.	99.	82	......	.....	.....
" 14, "	21	98.5	99.	84	......	.....	.....
" 15, "	22	98.5	98.5	84	......	.....	.....

CASE 502. CEREBRO-SPINAL

Thomas Cahil, Age, 16

DATE.	DAY OF FEV	TEMPERA.		PULSE.	
		M.	E.	M.	E.
Dec. 26,'72	1	100.	99.6	100	97
" 27, "	2	101.	101.4	105	111
" 28, "	3	100.5	101.2	104	112
" 29, "	4	101.	101.6	58	[illegible]
" 30, "	5	101.2	102.1	108	[illegible]
" 31, "	6	101.	103.4	104	[illegible]
Jan. 1,'73	7	101.6	102.6	108	[illegible]
" 2, "	8	103.	102.5	102	[illegible]
" 3, "	9	102.2	102.	104	[illegible]
" 4, "	10	101.5	103.	104	[illegible]
" 5, "	11	101.8	98.5	102	[illegible]
" 6, "	12	101.4	104.	120	[illegible]
" 7, "	13	101°	103.	110	[illegible]
" 8, "	14	102.	102.5	104	[illegible]
" 9, "	15	102.2	102.	84	[illegible]
" 10, "	16	101.2	103.	98	84
" 11, "	17	102.2	102.	110	[illegible]
" 12, "	18	100.	101.2	112	86
" 13, "	19	101.8	100.4	102	94
" 14, "	20	101.	100.4	98	94
" 15, "	21	101.2	100.	100	96
" 16, "	22	99.	98.5	......	......

In the following cases (503, 504,) which I have consolidated from the clinical of Dr. J. A. Larrabee of Louisville, Kentucky, (Richmond and Louisville Journal, December, 1872, p. 764, (the highest point of temperature reached was

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*The clinical record of these cases, was furnished at my request, by Dr. Wm. that time resident student in the Charity Hospital. Accounts of these cases have lished by Dr. L. S. McMurtry, (New Orleans Medical and Surgical Journal,

Case 503: Cerebro-Spinal Meningitis.

T. W., bright active boy, æt. 3 years and 2 months, March 23d, 1872. The mother stated that about two o'clock, the night previous, he alarmed her by acting strangely. He became conscious after awhile, and complained of feeling sick. Pulse 125 per minute; anxious expression; jactitation of limbs, persistent vomiting of everything taken into the stomach, and constant retching when the stomach was empty; the eyes also were in constant motion, the lids widely open. Physical examination of chest showed slight dulness, with bronchial respiration over middle lobe of right lung; the condition of the other lung so far as any physical signs of pneumonia were concerned, was good; the most distressing symptom was the persistent vomiting.

March 25th. Passed a restless and uncomfortable night; bowels had been moved; vomiting only partially controlled, breathing hurried; pulse 130. 3.30 P. M.; temperature in axilla 105°, pulse 136; respiration 50 per minute. $\frac{1}{162}$ grain of Sulphate of Atropia, ordered to be given every two hours by stomach.

10 P. M. There was present every evidence of the peculiar effect of belladonna—redness of skin, dryness of mouth and fauces, with dilatation of pupils; temperature 103°.5, pulse 148; respiration 52. Ordered Atropine in same dose at four-hour intervals.

March 25th, 9 A. M. Pupils considerably dilated, mouth extremely dry, tongue constantly thrown out for water, which he drinks greedily, and occasionally vomits. Intellect seems to be a little clearer; when questioned makes an attempt to reply in a fretful manner; pneumonic signs better; returning crepitation at base; temperature 102°, pulse 38, and respiration 48; retains the Atropia, but vomits the water when taken in large doses.

6 P. M. Temperature 104°, pulse 130, respiration 52. His words, if he says anything, are incoherent; discontinue Atropia; has not slept a moment; ordered Bromide of Potassium with Opium, for sleep.

March 26th, 9 A. M. Condition in no way improved; has had no good sleep; the right lung is again beginning to do duty; temperature 103°.5, pulse 144; respiration 148. To have no medicine by the mouth, but ordered turpentine and Carbonate of Ammonia, with $\frac{1}{32}$ grain of Morphia per rectum, every 4 hours.

7 P. M. Sleeping, with fair pulse, less frequent respiration, extremities cool, but not cold.

March 27th. Slept well most of the night; tongue not so dry; no sordes; temperature 102, pulse 120, respiration 44; left knee swollen, hot and tender; abdomen much distended and tympanitic. Ordered Tincture of Iodine to left knee; turpentine stupes to abdomen; bowels to be moved by simple enema; beef tea often by the mouth.

March 28th. A remarkable change has taken place during the last twelve hours; he is perfectly conscious, and has slept without the use of Morphia. Hands and feet quite cool compared with the previous fever heat; temperature 101°.5, pulse 25, respiration 40. Ordered Quinine 2 grs. every hour, beef tea and a little brandy at suitable intervals.

March 29. Passed a good night by aid of Morphia, to procure sleep, and appears to be somewhat refreshed and conscious; respiration 32, pulse 18, temperature 103°. Ordered beef tea with Quinine to be continued; increase the nourishment.

March 30th. Temperature 103°; respiration 24; pulse 108. Patient exhausted and weak; tries to talk, but is incoherent. Carbonate of Ammonia, with Quinine and beef tea.

March 31st. Rested well and awoke clear as to expression; cannot articulate his words well; complains when pressure is made over cerebral vertebræ; body covered with herpatic vesicles, eruption and sudamina.

April 5th. Tongue appears moist, with apthæ upon surface and edges; temperature 104°, pulse 120, respiration 28; left foot still swollen, eye looks better, pupils dilated; takes champagne and ice eagerly, talks thickly, chewing his words so as not to be understood.

April 21st. During the interval between the 6th, has had again acute hydrocephalic symptoms, screaming, etc., followed by paralytic symptoms upon right side, the left being entirely relieved. For six days past, has uttered no cry, and made no attempt to talk. At one time he was unable to swallow any nourishment, but during the past three days, has taken egg-nog and milk quite freely, when placed in his mouth, but manifests no desire for anything, swallowing it mechanically when so placed. He does not yet articulate a sound, except when his head is raised from the pillow, the back of his neck touched, or he is turned in bed; at such times he makes a faint noise, and his face bears an expression of pain.

April 30th. Emaciation of trunk and lower extremities, sunken belly, herpetic vesicles over skin. Last night irregular spasms began; at first consisting in slight trembling of upper extremities, the hands, arms and face, being only affected. During the night spots appeared over face, arms and trunk; some red, others of livid hue; varying from the size of a pea to a nickle. He was unable to make the slightest movement with the right leg, which was stiff and rigid; could not be bent or moved.

May 3d. Rested well all night, and looks better.

May 4th. Not so well, had a return of trembling, but no convulsion; right pupil greatly dilated. Has not given any sign of consciousness, but lies like a piece of marble statuary; the skin for the most time of a marble whiteness, becomes suddenly suffused with a pink color, which passes away. Several times his breathing during the last few weeks has become so gentle and unobserved, that he was thought by his friends to be dead. There is complete deafness and blindness.

May 15th. This is the eighth week of the disease, and from the last record, there has been little or no change in the symptoms. He does not stir in bed, nor change position of his own accord. To day the right leg is stiff and motionless. A blister applied over the occiput and back of neck drew well, and was filled with gelatinous matter. The pupil of the right eye is dilated; an examination of the retina by the opthalmoscope showed that it was of a deep red color, and the vessels turgid; the left pupil is fixed and too opaque by lymph to be examined. He did not appear sensitive to the strong light; but a slight contraction of the pupil was noticed. The emaciation of the trunk and extremities is frightful; the face does not show much emaciation.

May 30. Tenth week of illness, and 70th day after commencement of treatment. During the past week, there has been more marked rigidity of muscle, the legs and arms, are as stiff and immovable as marble; trembling spells become more frequent, and always accompanied by an effort to move. During these spells, the face becomes quickly tinted, and then crimson, afterwards deadly pallor succeeds. The emaciation is frightful; his face which until now has not participated much in the emaciation is slowly melting away. Although there is no pinched expression or mark of pain upon his countenance as he lies unconscious and motionless, and scrupulously neat in his snowy garments, h eis not unpleasant to look upon. The eruption upon the scalp discharges some matter; a blister has since been applied. To-day his mother gave him a strawberry; he ate it quickly and held open his mouth; a piece of bread was given him, and he spat it out; more strawberries were given and were eaten by him. This is the first taste and distaste he has shown.

June 15th. No important change.

June 29th. Thirteenth week, slight diarrhœa; same muscles contracted until their tendons stand out upon the thin wasted limbs like strings; right arm and shoulder badly swollen. Neither sees nor hears, nor is sensible to objects around him, although he is sensible to pain at times. Eats well, even hastily of nutritious food, such as eggs, whey, sponge cake, etc., and appears to like certain things, rejecting others, as soon as they are put into his mouth, but makes no sign of disgust at what he dislikes, until it is in his mouth.

July 13th. Sixteenth week; same, but more fretful from heat.

July 16th. Died this morning at 2 o'clock. Before he died he became opisthotonic; his back was a perfect arc, and his limbs were convulsed; the rigidity of certain muscles and sets of muscles was the same in twelve hours after death as during life.

Case 504: Cerebro-Spinal Meningitis.

Maggie Gagan; Irish girl, aged 13 years. Scrofulous nature, having suffered from hip-joint disease.

April 20th. Complained of great pain in head, limbs and chilliness. On Thursday previous to illness, she had competed with some children in jumping ropes; had reached one-hundred and fifty jumps without intermission, and being completely exhausted, she bathed her head in cold water, and drank of the same freely. She retained the dorsal position in bed, and the head was observed to be buried backward in the pillow; although no marked opisthotonos; has characteristic eruption. Temperature of axilla 105, pulse fast and small, 140 per minute.

April 22d. Appears easier, although in sound sleep; answers questions very slowly; intellect not clear; temperature 105°, pulse 135, little fuller.

April 23d. Temperature 103, pulse 120, tongue dry, cracked and sore.

April 24th. Appears to be much worse this morning; complete opisthotonos; frequent spells and screaming; pulse rapid and feeble; temperature could not be taken; is evidently sinking.

April 25th. No sleep, constant tossing about in bed, occasionally screaming; delirious. P. M. Appears to be worse; low muttering, delirium; pulse 150; restlessness of limbs.

May 4th. During the past week there has been but little change in the condition of the patient except emaciation; the pain continues in the head, and the rigidity of the neck also; is exceedingly feverish, but takes food and stimulants well; tongue and lips now clean; asked for her breakfast this morning, and ate with good appetite; the head is still drawn back, and the hands tremble considerably.

May 12th. End of third week; still lying conscious, feverish and fretful, with head drawn backwards; has become extremely emaciated; the sordes about the mouth and nose remain and bleed considerably; tongue perfectly clean; appetite good and even craving; digestion perfectly performed; stool each day; moves the right arm and leg with extreme difficulty.

May 26th. Commencement or sixth week of the disease. Tetanic spasm and opisthotonos have entirely disappeared; abdomen sunken and flat; skin considerably discolored.

June 12th. Has been sinking gradually, with an exacerbation of all symptoms since last record, vomiting at frequent intervals; screaming; opisthotonos retained; extreme emaciation and complete exhaustion, with coma at the last, from which she died at 2 o'clock in the eighth week of the disease.

I have consolidated and condensed the following cases, (505–554,) illustrating the changes of the pulse, respiration and temperature, from the "Notes of ninety-eight cases of Epidemic Cerebro-Spinal Meningitis, treated in the Philadelphia Hospital, (Blockley,) during the months of December, January, February and March, 1867, by W. H. H. Githens, M. D., Am. Jour. Med. Science, July 1867, pp. 17, 39.

Case 505. Age 47, male. *Result*, death in two days. *Symptoms*, delirium pain in head, nausea, coma, eyes closed, pupils contracted, chest and abdomen covered with eruption of small reddish brown spots, about one quarter of an inch in diameter; involuntary discharges in bed; skin dry.

Pulse, Respiration and Temperature. Temperature of axilla, 101° F.; Pulse 126, very weak. Head warmer than body; extremities cool; face darkly congested. Corners of mouth drawn down. Respiration labored and noisy; bronchial sounds, dry and metallic. Four hours before death pulseless, and bronchial sounds so loud as to mask sounds of heart.

Case 506. Age 40, female. *Result*, recovered in 10 days. *Symptoms*, semi-comatose condition, but when called loudly would open her eyes, and turn her head slightly; face darkly congested; pupils contracted; chest, abdomen and thighs thickly covered with petechial eruption; patient lies in bed in any position in which she is placed; involuntary discharges of urine and fæces.

Pulse, Respiration and Temperature. Temperature in axilla on 2d day, 103° F.; skin dry; head warmer than body; extremities cool. No *calor mordax*, the skin feels simply warmer than natural. On the 4th day, when there was a slight improvement of symptoms, and the eruption was disappearing, the pulse was 140; small and thready: 5th day, pulse improved 120 per minute; 7th day pulse full, 90 per minute.

Case 507. Age 28, male. *Result*, recovered in 21 days. *Symptoms*, pain in head, back thighs and calves of legs; petechial spots over chest, abdomen, and thighs; great muscular depression; patient describes the pain in the head as resembling the compression of a band of iron; pain and tenderness in neck and along back; mind clear; corners of mouth drawn down; eyes widely open giving the patient a staring expression

Pulse, Respiration and Temperature. 15th day of disease, temperature, 10 A. M., 103° F., pulse 102, respiration 33; 6 P. M., temperature 103°.5, pulse 100, respiration 34. 16th day, 6 A. M., temperature 101°, pulse 86, respiration 36; 12 M., temperature 101°, pulse 72, respiration 28; 6 P. M., temperature 101°, pulse 76, respiration 32. 17th day, 6 A. M., temperature 101°.25, pulse 74, respiration 20; 12 M., temperature 101°, pulse 86, respiration 28; 6 P. M., temperature 100°.25, pulse 90, respiration 32. 18th day, 6 P. M., temperature 99°, pulse 84, respiration 28; 12 M., temperature 98°.75, pulse 84, respiration 24; 6 P. M., temperature 98°.5, pulse 76, respiration 24. 19th day, temperature 97°, pulse 76, respiration 28; 12 M., temperature 96°.75, pulse 66, respiration 28; 20th day, 6 A. M., temperature 97°, pulse 80, respiration 28; 12 M., temperature 98°, pulse 78, respiration 28; 6 P. M., temperature 98°.5, pulse 86, respiration 32. 21st day, 6 A. M., temperature 97°.5, pulse 72, respiration 32.

Case 508. Age 36, male. *Result*, recovered in 16 days. *Symptoms*, intense nervous excitement, universal tremor pervading the whole body; tongue tremulous; intense pain in head located in occipital and temporal regions; unable to sleep by day or night; pupils small; conjunctiva injected; eyes prominent and staring; hyperæsthesia of skin; respiration irregular; abdomen, chest and thighs, thickly covered with reddish brown petechial eruption.

Pulse, Respiration and Temperature. 7th day of disease, 10 A. M., temperature 103°, pulse 126, respiration 36; 6 P. M., temperature 103°, pulse 112, respiration 28. 8th day, 6 A. M., temperature 101°.5, pulse 116, respiration 24; 12 M., temperature 101°, pulse 128, respiration 28; 6 P. M., temperature 103°, pulse 116, respiration 28. 9th day, temperature 102°, pulse 126, respiration 32; 12 M., temperature 102°, pulse 130, respiration 36; 6 P. M., temperature 102°.5, pulse 128, respiration 32. 10th day, 6 A. M., temperature 102°, pulse 124, respiration 40; 12 M., temperature 100°.5, pulse 134, respiration 28; 6 P. M., temperature 101°.5, pulse 136, respiration 36. 11th day, 6 A. M., temperature 101°.5, pulse 140, respiration 28; 12 M., temperature 101°, pulse 140, respiration 32; 6 P. M., temperature 101°.5, pulse 120, respiration 32. 12th day, temperature 101°.5, pulse 132, respiration 36; 12 M., temperature 102°, pulse 136, respiration 36; 6 P. M., temperature 102° 74, pulse 140, respiration 36. 13th day, temperature 102°, pulse 106, respiration 32; 12 M., temperature 103°.25, pulse 120, respiration 32; 6 P. M., temperature 102°, pulse 120, respiration 36. 14th day, 6 A. M., temperature 100°.25, pulse 106, respiration 32; 12 M., temperature 101°.5, pulse 108, respiration 36; 6 P. M., temperature 101°, pulse 112, respiration 24. 15th day, 6 A. M., temperature 101°, pulse 92, respiration [illegible]

12 M., temperature 98°.5, pulse 108, respiration 28; 6 P. M., temperature 99°.5, pulse 92, respiration 32.

CASE 509. Age 43, male. *Result*, death in seven days. *Symptoms.* Expression stupid and heavy, petechial mottling on abdomen and thighs, on 5th day decided opisthotonos, involuntary discharges from rectum and bladder, stupor.

Pulse, Respiration and Temperature. 3rd day of disease, 6 A. M., temperature 98°, pulse 124, respiration 28; 12 M., temperature 100°, pulse 130, respiration 32; 6 P. M., temperature 101°.5, pulse 132, respiration 28. 4th day, temperature 99°.5, pulse 112, respiration 24; 12 M., temperature 100°.5, pulse 120, respiration 24; 6 P. M., temperature 99°, pulse 128, respiration 24. 5th day, 6 A. M., temperature 99°, pulse 110, respiration 20; 6 P. M., temperature 99°, pulse 100, respiration 28. 6th day, 12 M., temperature 98°.5, pulse 104, respiration 28; 6 P. M., temperature 96°, pulse 112, respiration 24. 7th day, 6 A. M., temperature 92, pulse 102, respiration 24.

CASE 510. Age 52, male. *Result*, death in 8 days. *Symptoms*, diarrhœa, marked petechial eruption, eyes prominent and staring, corners of mouth drawn down, active delirium on 4th day.

Pulse, Respiration and Temperature. 3rd day of disease, 6 P. M., temperature 103°.5, pulse 120, respiration 40. 4th day, 6 A. M., temperature 101°.5, pulse 108, respiration 36; 6 P. M., temperature 102°.5, pulse 120, respiration 40. 5th day, temperature 101°.5, pulse 104, respiration 32; 6 P. M., temperature 101°.5, pulse 120, respiration 40. 6th day, 6 P. M., temperature 101°, pulse 98, respiration 48. 7th day, temperature 101°, pulse 86, respiration 28; 6 P. M., temperature 101°.5, pulse 142, respiration 32. 8th day, 6 A. M., temperature 100°, pulse 112, respiration 48; 6 P. M., temperature 100°, pulse 152, respiration 52.

CASE 511. Age 51, male. *Result*, recovered in 28 days. *Symptoms.* Severe headache, chill, profuse petechial eruption, coma, subsultus tendinum, opisthotonos, hyperæsthesia, sequlæ, complete deafness and paralysis of left foot.

Pulse, Respiration and Temperature. Pulse small and feeble, varying from 120 to 150. Temperature, maximum 102°.75, minimum 97°.5, mean 100° F.

CASE 512. Age 45, male. *Result*, death in 12 days. *Symptoms.* Severe headache, delirium, constipation, vomiting, opisthotonos, hyperæsthesia; no eruption.

Pulse, Respiration and Temperature. Pulse strong and irritable, 116 to 120; temperature, maximum 105° F., minimum 101°.5, mean 103°; death on 12th day from choking up of bronchial tubes with thick mucus.

CASE 513. Age 35, male. *Result*, recovered in 16 days. *Symptoms*, violent headache; no delirium; constipation; severe and general muscular pains. The temperature ranged from 99° to 95°; and the pulse from 96 to 62.

CASE 514. Aged 30, male. *Result*, death on 23d day. *Symptoms.* For the first fortnight had all the symptoms of well marked Typhoid Fever, with the exception of the eruption, which was petechial in character, stupor and coma constant for several days before death. Temperature, max., 104°.5; min., 97°.75; mean, 102°.5; pulse, 88 to 134, barely perceptible.

CASE 515. Age 45, male. *Result*, recovered in 12 days. *Symptoms*, violent headache; no delirium; no petechiæ; some muscular pains; severe headache; slight opisthotonos, with subsultus. Temperature, 99°; pulse, 62-80.

CASE 516. Severe headache; opisthotonos. Temperature, max., 102°.5; min., 98°; mean, 101°. Pulse feeble, 72-86.

CASE 517. Age 22, male. *Result*, death on 21st day. Temperature, max., 104°.75; min., 97.°5; mean, 102°. Pulse 86 to 120.

CASE 518. Age 20, male. *Result*, death. Moribund when brought into hospital. Temperature, 101° to 103°. Pulse 110 to 120, feeble.

CASE 519. Age 23, male. Death 8th day. Severe headache, opisthotonos, delirium, conjunctiva congested. Temperature, 101°; pulse, 100 to 110, feeble.

CASE 520. Age 45, male. Death 11th day. Severe headache, delirium, constipation, hyperæsthesia, opisthotonos, screaming. Temperature, 101°; pulse, 110 to 130, very feeble.

CASE 521. Age 35, male. Cured in 7 days. Headache, constipation, stiffness of back. Temperature, 100° F.; pulse, 76 to 112.

CASE 522. Age 22, male. Recovered 14 days. Severe headache, muscular pains of head and back, stiffness of legs and back. Temperature, 99°; pulse 76 to 104.

CASE 523. Age 42, male. Cured 5 days. Constipation, headache, pain upon pressure over cervical vertebræ. Temperature, 100°; pulse 76 to 112, feeble.

CASE 524. Age 53, male. Death in 12 days. Severe headache, wild delirium, opisthotonos. Temperature, 101°; pulse, 74 to 130.

CASE 525. Age 24, male. Recovered in 14 days. Intense headache, bowels constipated, muscular pains in back, slight opisthotonos. Temperature, 98° to 103°.5; pulse, 92 to 146.

CASE 526. Age 26, male. Died on 10th day. Coma, bowels constipated, opisthotonos. Temperature, 96° to 104°; pulse, 98 to 144.

CASE 527. Age 54, male. Died 2d day. Intense headache, constipation, opisthotonos, eruption. Temperature, 103°.

8. Age 21, male. Recovered in 27 days. Slight delirium, slight headache, con-
Temperature, 97° to 104°.5; pulse, 72 to 112.
9. Age 20, male. Recovered 15 days. Severe headache, stiffness of back, hyper-
erythematous eruption. Temperature, 96° to 104°; pulse 72 to 106.
0. Age 44, male. Recovered in 8 days. Slight delirium, continued headache, con-
opisthotonos. Temperature 98° to 101°; pulse 88 to 112.
1. Age 26, male. Recovered in 14 days. Active delirium, severe headache, con-
erythematous eruption. Temperature, 97° to 103°; pulse, 86 to 120.
32. Age 21, male. Recovered in 17 days. Muttering delirium, severe frontal
constipation, muscular pain in neck, opisthotonos. Temperature, 97° to 104°;
to 120.
3. Age 67, male. Recovered in 10 days. Headache, constipation, erythema and
congestion of conjunctiva. Temperature, 97° to 102°; pulse, 76 to 120.
4. Age 22, male. Recovered in 20 days. Delirium, headache, constipation, opis-
hyperæsthesia, eruption, erythema and petechiæ. Temperature, 96° to 104°.5;
to 120.
35. Age 16, male. Recovered 5 days. Severe headache, constipation, vomiting,
pains. Temperature, 97° to 103°; pulse, 76 to 126.
6. Age 30, male. Recovered 22 days. Intense headache, constipation, opistho-
eræsthesia, petechial eruption. Temperature 97° to 103°; pulse 80 to 120.
7. Age 36, male. Death in 11 days. Constipation, muscular pains, hyperæsthesia,
eruption and erythema. Temperature, 94° to 104°; pulse, 112 to 120.
8. Age 46, male. Recovered 8 days. Headache, constipation, muscular pains.
re, 95° to 105°.25; pulse 68 to 96.
39. Age 22, male. Recovered in 14 days. Severe frontal headache, muscular
n on pressure of dorsal vertebræ, congestion of conjunctiva. Temperature, 97 to
se 70 to 106.
0. Age 40, male. Recovered 14 days. Active delirium, severe headache, vom-
cular pains. Temperature 99° to 104°; pulse 80 to 130.
1. Age 21, male. Recovered 20 days. Headache, diarrhœa, vomiting, muscular
echial eruption.
2. Age 31, male. Recovered 28 days. Severe headache, coma, constipation,
pains, deafness and loss of memory. Temperature, 99° to 104°.5; pulse, 90 to 120.
3. Age 13, male. Death 10th day. Delirium, coma, injection of eye, petechial
Temperature, 104°.5; pulse, 120 to 140.
4. Age 27, male. Recovered 21 days. Active delirium, some frontal headache,
muscular pains, petechial eruption. Temperature, 98° to 103°; pulse, 90 to 120.
5. Age 30, male. Recovered 28 days. Delirium, severe frontal headache, opistho-
ere muscular pains, copious eruption, deafness. Temperature, 97° to 103°; pulse,

6. Age 25, male. Recovered 21 days. Headache, delirium, diarrhœa, muscular
emperature, 98° to 104°.75; pulse, 136.
7. Male. Recovered 21 days. Headache, delirium, nausea, pain in muscles of
back, suppuration of parotids. Temperature, 97°.5 to 102°.
8. Age 60, female. Died 6th day. Severe headache, constipation, opisthotonos,
esia, petechial eruption. Pulse 112 to 120.
9. Age 36, male. Died 9th day. Severe headache, constipation, eruption of
Pulse could not be felt.
0. Age 57, male. Died in 60 hours. Severe headache, constipation, muscular
lse 116 to 120.
1. Age 32, male. Recovered 18 days. Headache, muscular pains, opisthotonos.
o 130.
2. Age 25, male. Recovered 21 days. Active delirium, coma, muscular pains,
os. Temperature, 98° to 104°; pulse, 80 to 130.
3. Age 65, male. Died 9th day. Headache, constipation, petechial eruption,
o 90.
4. Age 29, male. Recovered 21 days. Intense headache, constipation, muscular
eræsthesia. Pulse 86 to 140.

y of the cases observed by Dr. Githens, the temperature was lower than that re-
typhoid or inflammatory diseases; the observations were made at 6 A. M., 12 M.
M. daily; and were taken as far as possible, in typical cases, and in those
temperature was most elevated, and yet the average is lower by four or five
han that of typhus or typhoid fevers, pneumonia, etc. In two cases only did
ometer in the axilla reach 105°. In fifteen cases it was between 104° and

105° ; in twelve between 103° and 104° ; in seven between 102° and 103° ; in six between 101° and 102° ; and in two it was below 100°; records being made in forty-four cases. The numbers given are the highest point reached in each case. The difference in the temperature at the evening and morning observations, was not so marked as in most other fevers, a fall of more than one degree being unusual, and frequently there was no change. A regular and gradual descent, indicated the beginning of convalescence ; a rapid fall was the sure precursor of collapse.

The pulse varied from normal to 150 beats per minute in ten uncomplicated cases, and ranged as high as 160 in two cases in puerperal women , it was in all, very weak, with a dichrotic tendency ; sometimes entirely imperceptible in the radial artery, and always interrupted by a very slight pressure. It appeared to be the most deceptive symptom, as no one would have suspected an inflammation of a high grade, with a pulse, which, although, sometimes quick, was very strong, but always gaseous and feeble in the extreme. Am. Jour., Med. Sci., July 1867, p. 38

Dr. J. Baxter Upham, of Boston, in his " Additional Reflections upon the Late Epidemic of Cerebro-Spinal Meningitis," states that in the replies to the circular issued under the auspices of the Massachusetts State Board of Health, from about two hundred physicians, representing seventy-two towns and cities, and containing the data, more or less complete, of upwards of five hundred cases of disease, " the temperature is not given as often as could be wished, and when indicated, the period of the day, or the stage of the disease has not been particularized. In several cases, however, a very high temperature has been noted, as high as 108°.25 by Dr. Wm. Read, and in one instance (that of a boy eight years of age,) by Dr. Ira Russell, as high as 110°." Boston Medical and Surgical Journal, vol. xci, 1874, No. 10, p. 226.

According to J. Tourdes, in the epidemic of Cerebro-Spinal Meningitis, observed at Strasbourg, 1840 and 1841 ; at the onset there was no fever, even when the pulse was accelerated ; the temperature of the skin was natural, or sometimes even lowered ; and there was always a complete absence of fever in cases which terminated fatally within the first few days ; but when the attack was of more than a week's duration, a true fever was lighted up which remained until convalescence or death ; this fever was of the continued type, but presented marked and regular exacerbations, which took place in the afternoon along with an aggravation of the other symptoms. According to the writer, the force of the fever, was sometimes, although rarely, inflammatory ; more generally it was typhoid.

J. Burdon-Sanderson, in his " Report of the Result of an Inquiry into the Epidemics of Cerebro-Spinal Meningitis, prevailing about the Lower Vistuta, London, 1865," states, that in adults the temperature varied from 100° to 104°, and in children was still higher. Exacerbations of Pain, were always accompanied with an increase of heat of the skin, amounting to 2° or 3°.

Dr. Felix Von Niemeyer, states, that in the first stage of the disease, up to the third or fourth day, although the pulse may be over 120, and the respiration of 40 per minute, the bodily temperature still remains proportionately low, or rises to 102° or over.

According to Ziemssen's numerous observations, the *fever* has no regular course ; very few temperature curves resemble each other ; sudden leaps, and exacerbations of short duration often occur ; but generally a remitting type, with exacerbations of half a degree to a degree, is most frequent ; very high temperatures are almost exclusively seen in severe cases that terminate fatally, in most cases the temperature being not above 103°. The intermittent fever that occasionally accompanies the other symptoms during convalescence is regarded by Ziemssen, as a *re-absorbing fever*, while he refers that occurring during the second week to an interrupted progress of the Meningitis. The frequency of the pulse does not at all accord with the height of the fever.

According to Wunderlich, Epidemic Cerebro-Spinal Meningitis being obviously a form of disease, which in spite of the actual identity of the anatomical lesions, may present itself under apparently widely different symptoms, the temperature, may pursue varied courses. From more than thirty cases observed by Wunderlich, it appears to this accurate observer, that three special varieties of the fever course, can be particularly distinguished.

(*a*). In some *very severe*, and rapidly fatal cases, the temperature displays a similar course to that of Meningitis of the convexity. Though not invariably very high at the beginning of the disease, it reaches very striking heights in the briefest time, which persist continuously for some days, and rise just near death, and in the very moment of death to quite unusual degrees, 42° C. (107°.6 F.) and more; and in one case, 43.75 C. (110.75) in dying, and may even rise some tenths higher after death (three quarters of an hour after death in the case just mentioned), it was 44°.16 C., (111°.48 F). Wunderlich also observed some fatal cases, in which the temperature for some time was very moderate, and rose considerably all at once just near the end of the disease.

(*b*). On the other hand, relatively *mild* cases, exhibit only a fever of short duration, although there are sometimes considerable elevations of temperature (which contrast with the quick pulse), and the course is generally discontinuous. Recovery does not take place by decided crisis, but generally happens, rather with remittent defervescence (lysis); and the pulse then begins to quicken just as the temperature has become normal or nearly so. Here and there cases occur, which after differverscing, and apparently almost recovering, relapse all at once, with a rapid rise of temperature, and run a course like the cases marked (*a*).

(*c*). In contrast with these brief courses of fever with either very severe or slight characters, we find cases, which are more or less *protracted* with a corresponding course as to the fever. The height of the temperature in these may be very varied, and indeed, exhibit manifold changes in the very same case, though, indeed, this chiefly depends upon the varied complications which supervene in the shape of bronchial, pulmonary, and intestinal affections, and affections of the serous membranes. Sometimes the fever has the same duration, and the exacerbations of the temperature, the same height as those of typhoid fever, and its curves, when projected, may greatly resemble the latter; but there is not the irregularity of abdominal typhus, and at the best, the course is only that of the amphibolic period of that disease, or like that which occurs in very irregular forms of it. Fluctuations of considerable extent, apparent improvements, and fresh and sudden rises of temperature are met with. Sometimes the course resembles the fever of phthisical patients.

Deffervescence may occur rapidly, but is however, for the most part protracted by lysis. With a fatal termination, there may be either a rising or falling temperature, according to the kind of case, and the various immediate causes of death.

Wunderlich has related at some length a remarkable case, in which both the course of the temperature and the other symptoms, rendered the diagnosis doubtful for a long time, whether he had to do with abdominal typhus or Cerebro-Spinal Meningitis. Archiv der Heilkunde, iv, 271; v, 417; ibid, 1865, vi, 268.

On the Temperature in Diseases, a Manual of Medical Thermometry, by D. C. A. Wunderlich, New Syd. Soc., London, 1871, pp. 388–391.

The important conclusion deduced from the preceding observations, is that:

The temperature in Cerebro-Spinal Meningitis varies in accordance with the extent and character of the local inflammation, and does not manifest regular and defined changes, as in the essential fevers; it is evident, therefore, that the febrile phenomena of Cerebro-Spinal Meningitis are not to be referred to a definite poison acting primarily upon the blood.

BLOOD.

As far as my investigations have extended, the fibrin is increased, as in inflammations generally.

Ames states that the blood taken from the arm, and by cups from the back of the neck, coagulated with great rapidity; its color was generally bright, in a few cases nearly approaching to that of arterial blood; it was seldom buffed; in thirty severe cases in which its appearance was noted, it was buffed in only four. Analyses were made in four cases, the blood being taken, early in the disease, from the arm, and was the first bleeding in each case. The first was from a laboring man, thirty-five years old; the second from a boy twelve years old, while comatose; and the two others from stout women, between thirty and thirty-five. In the first analysis, Fibrin, 6.40; Corpuscles, 140.29. Second analysis, Fibrin, 5.20; Corpuscles, 112:79. Third analysis, Fibrin, 3.64; Corpuscles, 123.45. Fourth analysis, Fibrin, 4.56; Corpuscles, 129.50. Tourdes states that blood drawn from a vein was rarely buffed; if a buffy coat existed, it was thin, and generally a mere iridisation upon the surface of the clot; analysis furnished the following results: First analysis, Fibrin, 4.60; Corpuscles, 134. Second analysis, Fibrin, 3.90; Corpuscles, 155.54. Third analysis, Fibrin, 3.70; Corpuscles, 143. Fourth analysis, Fibrin, 5.63; Corpuscles, 137.84. Maillot gives as the result of analysis in six cases, an increase of fibrin to six parts, and more in a thousand.

It is evident, therefore, from these Quantitative Analyses, that the blood in Cerebro-Spinal Meningitis, represents the condition of this fluid in inflammatory diseases.

PATHOLOGICAL ANATOMY OF CEREBRO-SPINAL MENINGITIS.

Near the close of the recent civil war, and shortly after my return to Augusta from the Army of Tennessee, a most favorable opportunity occurred for the careful investigation of the pathological anatomy of this disease. During the months of January and February, 1865, Cerebro-Spinal Meningitis appeared in one regiment of a brigade of Georgia militia, which had been summoned for the defence of the city against the threatened attack of General Sherman. The brigade was camped on the Sand Hills, about three miles from Augusta. The Third Regiment of Georgia militia, in which six cases of Cerebro-Spinal Meningitis occurred, were camped in a valley between the hills occupied by the remainder of the brigade. As far as my information extended, the troops camped upon the dryer and warmer hills escaped this disease. Three of the six cases died in camp, and the remainder were sent to the general hospitals in Augusta, and in like manner terminated fatally. The symptoms manifested by these cases were clearly those of Cerebro-Spinal Meningitis; the first symptoms which attracted attention being nausea, vomiting, diarrhœa and convulsions, followed with severe pain in the head, extending along the spine, alternate contraction and dilatation of the pupils, deafness, low-muttering, spasms; delirium and coma.

Case 555: Cerebro-Spinal Meningitis.

In the case of Private Goosby, of Company J., 3d Regiment, Georgia Militia, age 28; the first symptoms noticed by the Medical Officers, were soreness in the chest, and cough, accompanied with pain in the head and back, and with nausea and slight diarrhœa. This patient was sent to the 3d Georgia Hospital in Augusta, on the following day, February 13th, 1865, and at the time of his admission was rational and complained of pain in the back and extremities; the symptoms of Cerebro-Spinal disturbance, progressively increased, and upon the next day, February 14th, delirium set in, with incontrollable restlessness, and loud cries and shrieks. In lucid intervals, and when aroused from the delirium, the patient complained of violent pain in the head. A large blister was applied to the back of the head and neck, and ten ounces of blood abstracted, and quinine freely administered at intervals. These measures appeared to afford some temporary relief, but the disease progressed steadily, the prominent symptoms being characterized by muttering, delirium, contraction of the pupils, deafness, rigid contraction of the muscles of the neck and spine, slow pulse and impeded respiration and torpid bowels. Death occurred on the 25th of February.

AUTOPSY EIGHT HOURS AFTER DEATH.

Cerebro-Spinal System.—After the removal of the Skull Cap, the dura-mater of the brain, presented a normal appearance, there were no marks of inflammation, and no effusion between this membrane and the arachnoid.

The arachnoid presented an opalescent appearance, where it passed over the sulci of the cerebrum and cerebellum.

The pia-mater of the brain, was greatly congested, and the larger veins and many of the arteries were distended with dark blood.

The Pons Varolii, Medulla Oblongata, and Spinal Cord, were coated with a firm, light-greenish yellow, wax-like fibrinous exudation; large tracts of the cerebrum and cerebellum were also thinly coated with this effusion, which also surrounded the Cauda Equina and most of the roots of the spinal nerves, up to their entrance within the dura-mater of the Spinal Cord.

This exudation possessed various degrees of consistence, from that of a serous fluid to a newly formed membrane, and differed in thickness, in different parts of the Spinal Axis.

The exudation at the base of the brain, where it covered the Pons Varolii, and Medulla Oblongata, was of considerable thickness and firmness, and extended laterally, gradually diminishing in thickness, to the convolutions of the cerebrum and cerebellum. Over the cerebellum and cerebrum, the deposit was much thinner and less consistent than at the base of the brain, and around the spinal cord, and in many places it required close inspection of the pia-mater for its discovery.

When a section of the brain was made, so as to expose the ventricles, the third and lateral ventricles were found filled, and even distended, with a light, greenish yellow, semi-fluid exudation, resembling to the naked eye, pus. The optic thalami, and striated bodies, as well as the walls generally of the lateral and third ventricles, were coated with a layer of semi-organized plastic lymph.

The deposit was subjected to a careful microscopical examination. The points which I desired to settle by this examination, were:

1st. The nature of the effusion—whether pus? Or organizable and "organizing" lymph?

2d. The extent of the action of the organizing force, in the plastic elements and products of inflammation.

3d. What membranes of the brain and spinal cord were involved in the disease?

4th. Whether the nervous structures, themselves, commissures, ganglionic cells, and connective tissue of the nervous elements of the brain and spinal cord, were involved in the diseased action.

5th. Whether any of the effects and products of inflammation, could be detected by the microscope, in the nervous structures proper.

The following appeared to be the most important results of these labors.

Under the microscope, the exudation presented different stages of organization and development, from the simple granule, to the perfected fibre, and even fibrous tissue.

Although resembling pus, to the naked eye, the exudation possessed in its microscopical characters, and structure, a higher organization, and the more solid portions were rapidly passing into the state of an organized fibrous tissue.

The first question was of great interest and importance, and was settled beyond all cavil and doubt. The effusion and deposit, was organizable, and "organizing" lymph.

The effusion resembled in its physical, chemical and miscroscopical properties, the plastic lymph, thrown out in mechanical injuries, and in acute inflammation, pleuritis and peritonitis.

It is therefore incorrect to speak of the effusion in Cerebro-Spinal Meningitis, as Pus, or as Purulent matter. The effusion may in some cases degenerate, simply into purulent matter; but at first and in its essential nature, it consists of coagulable plastic organizable lymph, capable of conversion into fibrous tissue.

Without doubt in many autopsies, superficial observers have been deceived by the general appearance of the effusion, when seen by the naked eye.

I have embraced other and more recent opportunities of making careful examinations of the brain and spinal cord in this disease, and the microscopical characters of the deposit was in all respects similar to those now recorded. The organizable effusion presented various stages of cell developement, from the simple exudation corpuscles to organized tissue.

These facts struck me as being of importance, in that they connected this disease, with other forms of inflammation, as Pleuritis and Peritonitis; and also explained the great difficulties which lie in the way of recovery from an inflammation of the nutritive membrane of organs essential to life, surrounded by a bony case. The present case, had persisted for two weeks, and the results of post-mortem examination, indicated that the intensity of the inflammatory process had ceased, and much of the effused material was becoming organized. The mere presence of the organizable and organizing material, even after the subsidence of the active inflammation, constituting as it were, the essence of the disease, from the very structure and functions of the cerebro-spinal nervous system, and its bony envelope must give rise to various morbid nervous phenomena; and when the pressure upon certain portions of the nervous system becomes sufficiently great, produce irremediable disturbances in the muscles and organs supplied by the parts chiefly affected, and finally cause death.

The more fluid exudation of the ventricles, consisted of a serous fluid, in which floated numerous exudation cells, similar in all respects to those of ordinary inflammatory processes, and larger than pus corpuscles; free nuclei and granules were also present in considerable numbers. Many of these inflammatory exudation cells, were much larger than colorless blood corpuscles, and contained a number of nuclei; the most common form was the spheroid, but some cells, were seen floating in the clear liquid, of an oblong rhomboidal and spindle shape. The more solid and organized portion of the exudation lining the walls of the ventricles of the brain, contained larger and more fully developed, cells, many of which, appeared to be passing into the condition of fibres.

The firmer portions of the effused fibrous deposit covering the medulla oblongata, pons varolii and spinal cord, were seen under the microscope, to be passing rapidly into the condition of fibrous tissue, presenting numerous cells in various stages of development, forming fibres and coalescing, and interlacing with each other.

In the wax-like deposit, from the surface of the anterior columns of the medulla oblongata, the exudation corpuscles, spindle-shaped cells and elongated fibres, were held together by an amorphous matrix.

Careful microscopical examination failed to reveal any exudation corpuscles, in the nerve structures forming the walls of the ventricles of the brain.

The structures of the medulla oblongata, pons varolii, spinal cord and spinal nerves, were examined microscopically, but no exudation corpuscles were discovered within the nerve structures proper. Exudation corpuscles were observed adherent to the neurilemma of some of the spinal nerves, but none were discovered between the fibres or nervous tubes of the spinal nerves.

No exudation was observed on the external portion of the arachnoid between this membrane and the dura-mater.

The arachnoid could be lifted off the exudation in many places, in others it was adherent. Under the microscope the exudation corpuscles and elongated spindle-shaped, and branching cells and fibrils, were seen adherent to that surface of the arachnoid, which lies upon the pia-mater. The exudation appeared, therefore, to belong chiefly to the pia-mater.

The absence of the effects and products of inflammation in the nervous structures, in this case, is a fact of importance, in throwing light upon the sudden and apparently rapid course of many cases of Cerebro-Spinal Meningitis. As long as the nervous elements themselves are unaltered, it is not reasonable to suppose that active nervous disturbances would be manifested. It would appear that in these cases the effusion ely increased until the pressure upon important nervous structures gave rise sturbances of circulation, respiration, and muscular and mental action. The of the effusion within the ventricles, distending them and compressing the ing nervous walls, in like manner must have produced great derangement in the f the brain.

inal Cavity. I examined the liver and spleen with great interest, to deter- ossible, whether they bore any marks of active malarious disease.

er of this patient, during the earlier periods of his disease, was said by the physician to have been somewhat enlarged and tender upon pressure; the n of a blister over the region of the liver was thought to be necessary, and o have relieved the engorgement of the organ.

eath the large lobe of the liver was more congested, and of a darker and more color than usual; the small lobe of the liver, however, presented a normal appearance. The inferior surface of the liver presented a slate color. Under scope I discovered none of the altered colored blood corpuscles and dark frag- hæmatin characteristic of Malarial fever. The liver contained grape sugar ave shown to be absent from the liver of Malarial fever.

leen was somewhat larger than usual, and a little softer, but still very nearly size and consistence, and when cut and exposed to the atmosphere the spleen dly assumed the bright scarlet hue of the healthy spleen.

the microscope, the splenic mud presented the elements usual in healthy nd I observed none of the altered coloring matters, disorganized blood corpus- dark red and black angular masses of hæmatin characteristic of malarial

icroscopical characters of both the spleen and liver, were wholly different from Malarial fever, of even a few days duration; and I felt convinced from the f this investigation, in comparison with the results of numerous similar exami- in various diseases, that this patient had certainly not been afflicted with fever for a number of years previous, and perhaps not during life.

ucous membrane of the stomach was congested in spots, and under a magni- ss the blood-vessels of the highly colored and ecchymosed spots, presented a congested arborescent appearance. The punctated congestions were most s and marked in the cardiac portion of the stomach. Portions of the intestinal re more congested than in health, the congestion being greatest in the lowest f the ileum. This condition of the alimentary canal, was most probably the the free use of purgatives.

esenteric solitary and agminated glands presented an appearance of health;— nusual was noted in them.

entary. The following points were established by the investigation of this case o-Spinal Meningitis.

This was a typical case of Cerebro-Spinal Meningitis; the disease was epidemic ter, being one of a number of simultaneous cases; and the period of death red until all the phenomena had time for development; this then may be as a type of the epidemic form of Cerebro-Spinal Meningitis.

There was no complication with malarious disease.

The products of the inflammatory action resembled in all respects, those of and Peritonitis.

The inflammatory action appeared to be confined chiefly to the pia-mater, to a certain extent, also the arachnoid.

The nervous elements of the brain, spinal cord and cervical nerves (ganglionic missures, nerve tubes and nervous connective tissue,) appeared to be free from tory action.

If the nervous elements were primarily involved in Cerebro-Spinal Meningitis, be impossible to explain the suddenness and violence of the symptoms, and the al result in the absence of all lesions recognizable by microscopic investigation.

On the other hand it can be readily conceived, that the inflammation of the mucous membrane and the coating of the most delicate organs confined in a bony case with a dense exudation tending to organize itself progressively into more firm and resisting structure, might give rise to all the phenomena of Cerebro-Spinal Meningitis. An effusion of coagulable lymph is just as capable of producing pressure and deranged action in the brain and spinal cord, as an effusion or hæmorrhage of blood within the bony case of the cerebro-spinal system.

7th. This case furnishes an explanation of the almost universally fatal character of Cerebro-Spinal Meningitis, as well as of the tedious nature of recoveries from this disease. Even after the subsidence of all active inflammation in the meninges of the brain and spinal cord, the most serious consequences may follow, and all the dangerous symptoms and derangements in the most essential functions of life, may be kept up, by the mere mechanical action of the organizable and organizing fibrous effusion. The period of convalescence from this disease would depend, not only upon the amount of fibrinous plastic, inflammatory effusion, but also on the character and rapidity of the subsequent changes resulting in the formation of fibrous tissue, and in the gradual absorption of some portions of the products of the diseased action.

8th. The disease appeared to have been produced, in this patient, by the same causes which are active in the production of other inflammatory affections, as Pleuritis, Peritonitis, Pneumonia and Acute Rheumatism, viz: exposure, cold damp weather and the hardships of camp life.

9th. In its essential nature this case differed from a contagious malignant fever. There was not a single fact developed by the post-mortem examination, which would justify the classification of this disease with the pyrexiæ. If Cerebro-Spinal Meningitis belongs to the class of febrile diseases, then Pneumonia, Pleuritis and Acute Peritonitis should in like manner be stricken from the list of the phlegmasiæ. Writers have been led into error by attributing the mottled appearance of the surface and the changes of the secretions, as well as the marked disturbances of the circulatory and respiratory systems in Cerebro-Spinal Meningitis to the action of a specific poison, "*disorganizing*" the blood. It is entirely pertinent to ask: If the blood is so disorganized in this disease as to allow of the effusions of disorganized blood into the skin, why should all marks of disorganized blood and bloody effusions be absent from the structures most inflamed and diseased, the meninges of the brain and spinal cord? The fact is, that these discolorations of the skin in most cases of this disease, are not due to actual effusions of disorganized blood, but merely to irregular capillary action, and congestion dependent upon deranged nervous action and circulation. It is unnecessary in this connection to do more than allude to the effects of pressure upon the medulla oblongata, upon the functions of the circulation and respiration. And even if it be true that the blood is disorganized in certain cases of Cerebro-Spinal Meningitis, such disorganization may be entirely explained by the derangements of the circulation and respiration induced by the disturbance and perversion of the functions of the cerebro-spinal system.

10th. Cerebro-Spinal Meningitis being not an essential fever, but a local inflammation, the febrile phenomena being dependent upon the effects of the local lesions, it is not contagious; and therefore it may be treated in hospital wards, in contact with other patients, and all hygienic efforts should be directed to its original causation.

Another case of Cerebro-Spinal Meningitis occurred shortly after the preceding one, which afforded opportunity for careful post-mortem and microscopical examination.

Case 556: Cerebro-Spinal Meningitis.

Private H. Powell, Company D., 3d Georgia Reserves; age 20. Patient brought into Second Georgia Hospital, Augusta, Georgia, at 12 M., March 12th, 1865; inarticulate; lying on his back; neck curved back; quiet when left alone, but crying out with agony when moved, particularly when the neck was disturbed and moved from its curved position; pulse small, about 90 beats per minute, and quite quick; eyes slightly crossed, pupils dilated, but mobile and sensitive to light; hearing impaired and mind stupefied. The patient protruded his tongue, when ordered to do so. The tongue presented a healthy appearance. The

ıts who accompanied the patient from camp to the Hospital, informed the attendant
officer, Surgeon Joseph Ganahl, that the day previous, he was to all appearances,
and well, but was stricken down at 11 o'clock that night, insensible and speechless.
er upon which the patient was brought to the hospital, was befouled with his fæces
ıe.

atient was stripped, washed and put to bed, and was visited again two hours after-
and found still lying on his back, with neck curved, and body slipping towards the
the bed; these symptoms continued up to the period of his death. Although unable
ılate freely, nevertheless he seemed to be sensible when aroused, and answered plain
ıs. Upon one of the medical officers placing his hand upon the patient's head, the
rew his hand around the nape of his neck to support the cervical spine and prevent
ıotion.

llowing prescription was ordered and persisted in with the exception of the Quinine;
æ Sulph., grs. xx.; Hydrargyri sub-chloridi, grs. vi; Potassæ Nitratis, grs. xxxvi;
et Antimonii Tartratis, grs. ii; mix and divide into 12 powders, one powder every
ırs. This combination of drugs was thought by the attendant medical officer to have
the progress of the disease; the symptoms however continued much the same, (with
ption of a diarrhœa, which was controlled by the Camphorated Tincture of Opium.)
afternoon of the 16th, when the patient became very deaf, and was unable to articu-
o protrude his tongue. The next morning (March 17th,) the patient breathed in a
manner, with a wheezing sound, as if the bronchial tubes and air cells were full of
and died four hours after the morning visit of the attendant medical officer, apparently
arrest of the respiratory function. In *articulo-mortis*, his face was covered with pro-
spiration.

ollowing post-mortem examination was reported under my direction by Assistant
H. D. Schmidt.*

mortem Examination. Brain and spinal marrow, blood-vessels of the dura-mater and
er of the brain congested; the veins of the pia-mater were distended with black blood.
ce between the arachnoid and dura-mater, was filled with a serous fluid; and in the
anal, the dura-mater was so much distended by this effusion, as almost to fill up the
canal. By making an incision through the dura-mater, near the termination of the
ord, a considerable quantity of turbid fluid escaped. After the brain and spinal-mar-
re removed, it was found that a considerable exudation of already organized lymph
en place.

ibrinous exudation covered the entire base of the brain, embracing the upper half of
ulla Oblongata, Pons Varolii, with the Crura Cerebelli, Crura Cerebri, Locus Perfora-
pora Mammillaria, Tuber Cinererum, with its Infundibulum, Substantia Perforator
extending to the fissure of Sylvius on each side; and also covering the optic tracts of
ure.

ituitary Gland, appeared to be entirely free from exudation. From the Pons Varolii,
ulla Oblongata, the exudation extended to the Cerebellum, for the distance of half an
more, at the same time completely filling up the fourth ventricle, and thus pressing
e roots of the Pneumogastric nerves. The deposit also embraced and extended over
able portions of the nerves which emerge from the brain at the above mentioned points.
the posterior columns, and restiform bodies of the medulla oblongata, the deposit
lso to the cerebellum, extending for some distance into the valicula, and thus cover-
inferior vermiform process.

essels of the Ependyma of the lateral ventricles were congested, and the ventricles
ves contained a liquid exudation, which filled up the anterior and descending horns.
stance of the brain appeared to be of the usual consistence; the gray matter of the
was a little darker than usual.

pinal marrow was almost entirely covered by the exudation, especially that portion
ween the cervical enlargement and medulla oblongata, and from the cervical enlarge-
its very termination, embracing the Cauda Equina, the thickness of the exudation
e posterior columns, and extending to the antero-lateral columns, as far as the antero-
fissure, amounted almost to one-fourth of an inch. Over the anterior columns, with
eption of a few places, it was not quite so thick, being about $\frac{1}{16}$th of an inch.

ura-mater of the spinal marrow was greatly congested, amounting in some places even
mmation; in such parts this membrane adhered slightly to the arachnoid membrane.
essels of the pia-mater were also distended with blood, and the membrane itself inflamed,

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months before the close of the War, I applied to Surgeon General Moore, of the Confederate Army, in
1865, to relieve Assistant Surgeon H. D. Schmidt, from duty in the Conscript Bureau, and to assign him to
er my command, as an assistant in the prosecution of the investigations which I had conducted during the
ır.

quest was granted by Surgeon General S. P. Moore, and Dr. Schmidt reported to me for duty, near the close
ry, 1865. The ill-health of Assistant Surgeon Schmidt, as well as the sudden close of the war, precluded
or systematic labor.

and adhering to the exudation. By microscopical examination, it was found that the exudation corpuscles were lodged between the fibrous bundles of which the pia-mater is composed, and they were also detected in the neurilemma of the spinal nerves, to a distance of one-fourth of an inch, outside the dura-mater.

The exudation was of such consistence as to bear cutting with the scalpel, ; it consisted of exudation cells, of various forms and sizes, in their different stages of development, as they usually present themselves under like circumstances. Many of these cells were round, or larger, or smaller, resembling those found in liquid lymph; but the great majority of them had already become elongated and spindle shaped, and were bound together by a granular amorphous substance. The exudation almost everywhere, adhered very closely to the pia-mater, and in most places also to the arachnoid, which fact, together with the pressure of the exudation cells, in the meshes of the pia-mater, seems to indicate that the inflammatory product was thrown out by both membranes, but chiefly by the pia-mater.

Thorax, Lungs and Heart. When the cavity of the chest was opened, by carefully removing the sternum, and the entire cartilages of the ribs, about half a fluid drachm of a dark brown, very viscid matter, with a greenish tint, was discovered upon the anterior mediastinum, in the cavity of the left pleura; some of it was also seen to adhere to the parietal portion of the latter directly opposite, covering a space of about four inches in diameter. In the latter situation, this material was collected in masses in some places, from which it gradually subsided into a thinner layer, to be lost at the limits of the area it occupied. The substance appeared as if it had been splashed upon the membranes. The dark viscid matter taken from the cavity of the pleura, was found by Dr. Schmidt, upon microscopical examination, to consist of cells containing large nuclei, and of a great number of granules. The outlines of some of the latter were dark, but the majority were pale. The cells themselves were filled with a yellow transparent material, of a slightly greenish tint, which assumed a lighter color by the imbibition of water into the cells. These appeared to be altered cells of the epithelium of the pleura, whose typical form they had retained, notwithstanding the alteration in size. The size of these cells varied greatly, for while some of them were as large, or not much larger than the normal epithelial cells of the pleura, others had attained a diameter of $\frac{3}{100}$ millemetres, with a thickness of from $\frac{10}{1000}$ to $\frac{12}{1000}$ millimetres. By mutual pressure they had assumed a somewhat polygenal form, thus resembling hepatic cells. These elements were held together by a viscid mucus-like fluid, which under the microscope exhibited a yellowish tint. Upon chemical examination the dark matter gave the same reaction as bile.

The lungs were collapsed—a considerable portion of the posterior surface of the inferior lobe of the right lung, was of a dark yellow color. The rest had the natural appearance, with the exception of some portions, where the surface was elevated by emphysema.

Heart. All the cavities of the heart were filled with coagula of black blood, extending through the pulmonary artery and its branches.

Abdominal Cavity. The liver was considerably enlarged, and of a slate color, and the gall-bladder filled with very dark and viscid bile.

The spleen was enlarged and its capsule showed traces of former inflammatory disease, by its thickness, and fibrinous deposits of considerable size. These changes in the spleen and liver were not, as far as could be ascertained from the symptoms and the post-mortem examination, connected with the last fatal illness, but had existed perhaps for months previously.

The general results of the preceding post-mortem examination (Case 556,) correspond with those of Case 555.

In the latter case there were no facts to show that the slate color of the liver and the enlargement of the spleen, were marks of malarious disease, proceding pari-passu, with the Cerebro-Spinal Meningitis. On the contrary, the thickened state of the capsule of the spleen indicated that the lesion was of long standing. The Georgia reserves had seen considerable service, and a large proportion of the men had suffered with paroxysmal fever. It is probable, if not absolutely certain from the nature of the cells, that the collection of viscid matter upon the pleura, was in no way connected with the disease which caused death.

In the preceding cases, the most prominent anatomical lesions were found in the cerebro-spinal nervous system. In Cerebro-Spinal Meningitis, the pia-mater appears to be the chief seat of the inflammatory action, and the exudation of coagulable lymph; it would appear however, from the results of post-mortem examinations, that the arachnoid and dura-mater, and even the structures of the brain and spinal cord may be involved. The character and extent of the inflammatory changes, will depend in great measure upon the length of the disease. In those who have died suddenly after a short illness of a few hours, we often discover nothing more than an intense injection of the pia-mater, and of the substance of the brain and spinal cord.

I will proceed to compare the results of the investigations just recorded with those of various other observers, who have endeavored to illustrate the pathological anatomy of this disease.

I shall make no special selection of the cases and post mortem examinations, but will endeavor to present an accurate and unbiassed view of the pathological labors which throw any light upon the true nature and pathology of Cerebro-Spinal Meningitis.

The results of my investigations into the history of this disease in the Confederate Army, have been presented in the preceding and present chapter, together with full details of the symptoms and post-mortem examinations of the individual cases reported.

Dr. W. S. Armstrong, of Atlanta, Georgia, has recorded observations upon the epidemic of Cerebro-Spinal Meningitis, which came under his observation at Mobile, Ala., during the winters of 1863–64, and 1864–65.

The symptoms which characterized the cases occurring in this epidemic, either in the formative or advanced stage, were of an equally grave import. Some patients were suddenly attacked with coma, or stupor, so profound as to be with difficulty aroused, in the midst of good health, after taking a hearty meal, or after a full day's work; in other cases, vertigo, pain in the head and cervical region, extending along the spine, with lassitude and apprehension of impending danger, were observed; in others, again, chilly sensations at intervals of two or three hours, with cold extremities, followed by exacerbations of heat, flushed face and increased pulse. Delirium, more or less wild, with a disposition forcibly to leave the bed or room, was, in the outset, a prominent symptom. The condition of the pulse was variable, usually ranging from ninety to one hundred, hardly reaching one hundred and ten, unless just before the termination in death; on the other hand, it occasionally sank to forty or fifty beats per minute. Vomiting of bile and constipation were usually, in the beginning, prominent symptoms; the tongue was furred, and as the disorder advanced, the teeth became coated with sordes. The urine was high colored, scanty and often retained; at other times, especially towards the close, it passed involuntarily. Intolerance of light and sound, when present, appeared at the early part of the attack—the least ray of light being sufficient to cause spasmodic closure of the eyes and intense suffering; walking across the floor was excessively annoying to the sufferer; deafness and a general indifference to surrounding objects, was occasionally noticed.

The most prominent, and almost universal symptoms, were pain in the head and neck, accompanied by a tetanic rigidity of the cervical muscles, and of the large extensor muscles of the back. This trouble, slight at first, increased, until the head was drawn back on the shoulders, and no ordinary degree of force used by the attendants could overcome it. The muscles of the back and lower extremities were occasionally so much involved as to produce complete opisthotonos. In connection with this condition, paralysis of the muscles of the face was sometimes present, as exhibited in depression of the lower jaw, and protrusion of the cheeks and lips in expiration. Involuntary twitchings of the muscles, and want of prehension also, often existed—the patient being unable to drink without assistance. Strabismus, in one or both eyes, was met with in several cases. The appearance of the pupils was not always the same, in the majority of cases being dilated; sometimes one was contracted and the other dilated, and occasionally both were contracted. Delirium was not common in the latter stages, before coma set in, and was then of a low, muttering character. When coma came on, which was usually about the fourth or fifth day, the pupils became widely dilated, the pulse became more full, but it was never, as far as the observation of Dr. Armstrong extended, of a bounding character, as in coma from apoplexy. After the appearance of coma, involuntary discharges from the bowels and bladder were of frequent occurrence. Stertorous breathing was rarely present, and until the coma became profound, the patient continually tossed from side to side in bed, carrying the hands to the head as if in great pain. Another very common symptom was the hyperæsthesia of the whole nervous system, pressure upon the extremities, slight moving of the feet, or bending the toes, causing the patient to cry out with pain. This exaltation of sensibility did not appear at first, but towards the latter part of the attack. While vertigo, pain in the head, intolerance of light and sound, deafness, stupor, exalted sensibility of the nervous system, delirium and coma, were the usual symptoms by which this epidemic was characterized, yet there were a few cases of an intermittent type, accompanied by high fever, with pain in the head. Under the use of Quinia, these symptoms would yield for a few days, and convalescence seemed to be established. A recurrence of these symptoms would take place two or three times, when those more violent, as extreme pain in the head and neck, rigidity of the muscles, etc., would supervene, and declare unmistakably the formidable nature of the disease. The duration of the disease was variable, in some cases it destroyed life in from twenty-four to forty-eight hours; but from five to eight days was the usual time; during the winter of 1863–64, it proved fatal sooner than in the following winter,—a few of the last cases having lived from ten to fifteen days. The prognosis in this epidemic was unfaforable—in fact it was regarded as a *death warrant* to the subject; and Dr. Armstrong, notwithstanding that his observations were extensive among the soldiers and negro laborers in and around Mobile, never saw a single case recover. In the two varieties of cases which were observed, a treatment, supposed most likely to succeed, was adopted: in the one where there was much febrile excitement, anti-phlogistics were used; in the other, and opposite condition, a supporting plan was followed, and both alike with unfavorable results. Quinia in large doses, in previous epidemics, was found to relieve a certain percentage of those attacked, but in this it failed in doses from a scruple to a drachm. So likewise, Calomel was found to act beneficially in other epidemics, but at Mobile it failed even after its specific effects were produced.

Dr. Armstrong recorded four cases, illustrating the nature of this epidemic, and in the following cases post-mortem examinations were performed, which revealed the characteristic lesions of the brain and spinal cord;

Case 557: Cerebro-Spinal Meningitis. Effusion of Lymph on Cerebrum, and at the base of the Brain, Serum in lateral Ventricles.

Private, H. C., age about 40 years, was admitted into hospital, January 17th, 1865. Some six weeks ago, was exposed to the weather both day and night in camp; he had three chills, the last of which was congestive, and four days had elapsed before consciousness returned. In a short time he was convalescent. This history was obtained from a comrade. Present condition: he complains of soreness from head to foot, has frequent rigors, and is unable to express himself clearly; pulse 90; tongue moist and furred; bowels constipated. Ordered a Cathartic and Quinia. January 18.—Pulse 93; bowels moved five times from purgative; skin has been warm since admission; pain in the head and neck. Ordered blister to back of head and neck, repeat Quinia.

January 19th.—Pulse 90; pupils contracted; unconsciousness; head drawn back from contraction of muscles; breathes through his mouth; raises his hand to his head, as if in pain. To have a blister to the head.

January 20th.—No improvement; pulse 100 and weak. To have Cathartic and Spirits of Wine at short intervals. January 21st.—Pulse 120, and very feeble; skin warm and perspiring; comatose; opisthotonos, which began to develop itself yesterday, is very marked. Died at 11 P. M.

Autopsy January 22d.—The anterior two-thirds of cerebrum superiorly, are covered with an adventitious deposit of lymph, of a greenish color, forming adhesions between the arachnoid and pia-mater, and following the latter, as it dips down into the convolutions of the brain. The under surface of the anterior lobes, optic commissure, crura cerebri and pons varolii, are the seat of exudation also. Some pus is found at the medulla oblongata. This exudation is from one to two lines in thickness. The lateral ventricles are distended with effusion, which being drawn off, pus is found at the bottom. The choroid plexus is injected. The brain shows on section, no indications of softening, but appears healthy.

Case 558: Cerebro-Spinal Meningitis. Effusion of Serum in Arachnoid Space; deposit of lymph on Brain and Spinal Cord.

Private, W. F. Y.—Was admitted January 19th, 1865, at 10 A. M.—Pulse 86; skin moist and cool; pupils natural; restless; stares at his attendants; makes no reply to questions addressed to him; his cheeks protrude at each expiration. To have Quinia. January 20th.—Pulse 98; had several actions on bowels; pupils responded to light feebly; both wrists swollen and painful to the touch; notices what is going on in the room, but seems to be unable to articulate. Continue treatment. January 21st.—His mind is clearer; answers some questions rationally; for the first time he protrudes his tongue, which is furred and red; took some nourishment; bowels acted freely last night; picks at the bed clothes; has passed no urine since yesterday; one pint is drawn off. Continue treatment.

January 23d—Has been perspiring freely for several hours; delirious; head is drawn back, and to the right side; has had rigors since yesterday, at intervals; no action on bowels; drew off two pints of urine; ordered head to be shaved, and a blister applied; also a purgative. 3 P. M.—Pulse 140 and irregular; pupils contracted slightly; right eye drawn outwards; comatose; no action on bowels; drew off one pint of urine. Died in the early part of the night.

Autopsy. January 23d—Effusion of serum in the arachnoid cavity; membranes very much injected; light deposit of lymph between the pia-mater and arachnoid, on the anterior surface of the cerebrum, superiorly, extensively upon and around the optic commissura, over the entire cerebellum, crura cerebri, pons varolii, medulla oblongata, and spinal cord throughout its whole extent to the cauda equina. The nerves arising from the cord, on both sides, were enveloped with this deposit also. At several points along the cord it had degenerated into pus. The abdominal viscera, upon examination, appeared normal. The lungs were healthy also. The right side of the heart was distended with blood, and the right ventricle, contained a clot of fibrin, occupying half of its chamber.

Case 559: Cerebro-Spinal Meningitis; Deposit of Lymph, Superiorly and at the Base of the Brain; Serum in Arachnoid Cavity.

Private, W. J. H., was admitted on the 8th of December, 1864. The surgeon of his regiment informed Dr. Armstrong, that he was found in bed this morning, apparently suffering from congestive fever; the attack came on while asleep. At the present time, he is unconscious; pulse 119; pupils dilated; skin cool. To have stimulants, internally, and frictions with Spirits of Turpentine; also blister to head and spine.

December 9th.—Pulse 100, and increased in volume, but still not strong; teeth covered with sordes. Continue treatment. December 10th.—Pulse 120, and feeble; skin cool; comatose; died at 10 A. M.

Autopsy; December 11th.—Effusion in the arachnoid space. On the anterior surface of cerebrum superiorly, there is a deposit of adventitious membrane, also in its under surface as far back as the crura-cerebri. The cerebellum below, has a deposit of the characteristic greenish yellow appearance.

Dr. Armstrong also recorded a case of Cerebro-Spinal Meningitis, in which the disease made its appearance, whilst the patient was suffering from severe ptyalysm, from Calomel, and proved fatal on the sixth day. Atlanta Medical and Surgical Journal, N. S., June, 1866, vol. vii, No. 4, pp. 145–151.

Dr. W. C. Moore, of Atlanta, Ga., recorded four cases of Cerebro-Spinal Meningitis, one of which recovered, and three terminated fatally. The following is the record of the three fatal cases.

Case 560: Cerebro-Spinal Meningitis.

Was admitted at Ocmulgee Hospital, Macon, Georgia, September 4th, 1864. He was under the charge of a medical officer, who informed Dr. Moore, that he was received into the hospital three days before, with congestive chill. Malignant, intermittent and remittent fever, was then prevailing at Macon, among those not acclimated. The subject was a stout mulatto man, aged 30; apparently of a sanguine temperament. He died three days after, with all the symptoms of Cerebro-Spinal Meningitis.

Autopsy two hours after death. Arachnoid congested with effusion of plastic lymph over middle lobe, left hemisphere of the cerebrum, causing adhesions. Pia-mater greatly congested, especially between the convolutions; half pint of serum was discharged from ventricles, and folds of arachnoid. Dura-mater congested at and near lateral and cavernous sinuses. Substance of brain apparently healthy.

Case 561: Cerebro-Spinal Meningitis.

Admitted and treated at same hospital as the preceding case. Subject, a stout black man, aged about 25, of a strumous diathesis. Six days prior to death, was admitted with double pneumonia. He continued to grow worse for three days, when he comm complain of severe pain in the head, and in twelve hours was delirious, with great æsthesia, in which condition he died.

Autopsy four hours after death. All the membranes of the brain congested with serum in ventricles, and between folds of arachnoid. Great congestion of lateral base of brain. Both lungs in a state of red hepatization, except upper lobes, sions with effusion in pleural cavity.

Case 562: Cerebro-Spinal Meningitis.

Negro girl, aged 8, of strumous diathesis; was first attacked with influenza, in days became delirious; on the fifth day after the supervention of the head symptoms, rigidity of cervical and dorsal muscles, pupils of both eyes dilated, eyes injected, of skin normal. * * Died on the eleventh day, after the supervention of Meningitis. The following appearances are reported as having been disclosed by a mortem examination: All the membranes of the brain congested, but no effusion of lymph. Found pus and serum in ventricles. Substance of brain softened, with partial organization about the base. (Atlanta Medical and Surgical Journal, January, 491–497.

Dr. Sanford B. Hunt, in his report on Cerebro-Spinal Meningitis, published in *Sanitary Memoirs of the United States Sanitary Commission*, states as the his examination of *sixty-eight* autopsies, recorded by Confederate and Federal and American Physicians, that:

"All present positive evidence, not only that the meninges of the brain and spinal were the locations of inflammatory disease, but that the sufferers died from that inflamma and not from any intercurrent or other disease, which might cloud the discussion of essential cause of death. The appearances in other organs were mostly negative. of the patients had been healthy up to the hour when headache and nape-pain appear we find their organs after death exhibiting trivial signs of disease." (After accepting the of the autopsy previously recorded, case 555, as conclusive, as to the pathology of Spinal Meningitis, U. S. Sanitary Commission Medical Memoirs, pp. 393–396, Dr Hunt tinues): "We are inclined, therefore, to believe that the only essential pathological of epidemic Cerebro-Spinal Meningitis, is that which its name indicates—an inflamma the meninges, especially of the pia-mater, and that it does not differ in character or from ordinary phlegmasiæ of serous membranes. Its locality gives it a fatal tendency seen in pleuritis, but not much exceeding that of peritonial inflammation.'" *Sanitary Medical*, pp. 381–91.

Dr. J. Baxter Upham, in his account of an epidemic of Cerebro-Spinal which occurred in the winter and spring of 1862 and 1863, in the camps in and Newbern, North Carolina, describes the usual symptoms indicating lesions of the cerebro-spinal nervous system, as sudden attacks of pain in the back part of the excruciating pain in the back and limbs, sometimes accompanied with rigors, and and vomiting; a peculiar stiffness of the muscles of the face and neck, convulsions coma. Post-mortem examinations revealed opalescence of the arachnoid, vascularity of the membranes of the brain and spinal cord; large increase of the sub-arachnoid space, and in the ventricles oftimes turbid and mixed with of lymph, with an abundant exudation of thick yellowish, apparently semi-organized lymph at the base of the brain and in the medulla oblongata. Dr. Upham also passive congestions of the lungs, with spots of discoloration on the lungs, pulmonary apoplexy; in some cases, diffluent lymph in the pericardium, in instances sero-purulent fluids holding in suspension masses of flocculent lymph. some cases deposits of lymph were also noticed in the endo-cardium and the (Boston Medical and Surgical Journal, xxxvii, April 6th, 1863, 16, 34, etc.)

I have condensed the histories and post-mortem appearances of the following cases of Cerebro-Spinal Meningitis, from the report of Charles M. Clarke, M. D., Surgeon 39th Ill. Vol. Infantry, and Chief Operating Surgeon 24th Army (Chicago Medical Journal, vol. xxiv, No. 1, Jan., 1867, pp. 1–14, pp. 103-112).

Case 563: Cerebro-Spinal Meningitis.

amin Hyman, private, Company F, 11th West Virginia Regiment; American by birth;
years; admitted to hospital February 20th, 1865. On his admission he was fiercely
as. Pulse 80. Vomited a large quantity of dark green matter. Pupils of eyes
contracted; tongue moist and normal; skin dry and cold; hands and feet of a pur-
olor; urine scant and high colored; bowels costive. 21st. Restless and wild; no
pulse 120, very small and irregular. During the day petechiæ of various sizes com-
to appear, chiefly on fore-arms and legs. No considerable change, with the excep-
increasing weakness, until February 26th, when the pupils became dilated, and there
isposition to cough. The delirium at this moment was more mild; there was a dis-
to sleep, and the patient lay comparatively quiet on his bed.
1st. Continues apparently the same; dimness of vision noticed; he is also becom-
e deaf.
at gradually grew weaker, and died March 5th, 9 o'clock P. M. Just previous to death,
of acne broke out, most apparent about the face and neck, but some few crops were
the fore-arms and legs.
Cadav., 17 *hours after death.*—Rigor mortis well marked. Body not emaciated.
—Dura-mater greatly injected with both arterial and venous blood, and somewhat
ed. The arachnoid had a shiny, opalescent look, and was noticeably thickened at
he middle and on either side of the longitudinal fissure. Pia-mater covered with
of lymph and pus. On removal of brain from the skull, a large quantity of serum,
ith pus, escaped from the membranes of the spinal cord, and when the brain was
n the table, by slight pressure, some six ounces of serum escaped from the mem-
and third ventricle. In the spinal canal, three drachms of thick, yellow pus were
Over the pons-varolii, optic tract, and the base of the cerebellum, a thick layer of
pus was seen, and some was also found between the lobes of the cerebellum. The
ventricle contained three drachms of flaky serum; and in the anterior and posterior
there was one drachm of thick pus. The right lateral ventricle presented the same
nce. Pus was also found in the third and fourth ventricles. The brain tissue,
ly the cervical portion of both cerebrum and cerebellum, was soft and pultaceous,
ily broken down. The medullary portion did not seem greatly altered, although the
vasculos awere more numerous than usual.
acic and abdominal organs healthy.

Case 564: Cerebro-Spinal Meningitis.

es Reynolds; private, Co. I, 89th N. Y. Vols.; American; age 24 years. Admitted to
February 7th, 1865.
taken sick January 17th, with chill, severe pain in head, back, extremities, and the
of the body generally. Vomiting was an early and persistent symptom. A threaten-
apse occurred about twelve hours from the seizure, in which the patient came near
His eyes were red at first and discharged a little; his hearing was very acute, and
noise disturbed him greatly. There was great sluggishness in urinating. The head
posed to be retracted. He was rational all the time, no convulsions, no delirium, no
s. The pains gradually left him, and he was sent to the field hospital. The symp-
this man on entering the hospital, were: Slight pyrexia; eyes injected, looking like
of acute conjunctivitis; pupils greatly enlarged; very restless in body, but evinced
ngement of mind. He was not disposed to talk, but would answer questions correctly
ly. No delirium throughout. The heat about the head was greatly increased, and
as a constant desire to keep the head thrown back. This case passed on until 6 o'clock
eb. 13th, when he died comatose.
Cadav., 2 P. M., Feb. 14th.—*Head.* Extensive congestion of dura-mater; some slight
us between dura-mater and arachnoid. On reaching the pia-mater, there was quite a
flocculent serum, and on each side of the longitudinal sinus there was an extensive
ion of pus. On removing the brain, there was found, at the time the section was made,
derable flow from the meninges. There was a thick layer of pus over the whole of the
a oblongata. On opening the membrane near the optic commissure, there were found
nces of serum.
lateral ventricles and the fourth ventricle were full of turbid serum. The brain tissue
ftened throughout its whole extent. Upon examination of the cervical portion of the
ome pus was found, and the cord was softened.
.—Left lung covered with false membrane, and firmly bound down posteriorly; pleura
mly adherent to pericardium. Left lung full of tubercular deposit, chiefly of the
character. Right lung normal. Great hypertrophy of the pericardium on the left

side; no effusion within it. There was an abnormal fatty deposit over the whole surface of the heart.

Abdomen.—Substance of liver engorged; gall-bladder greatly distended; spleen and kidneys normal.

Intestines.—Omentum thickened and somewhat diseased; transverse colon contracted to one-third its normal size; ileum congested and coat thin, but not ulcerated. A lumbricoid worm was found in the jejunum. Descending colon thickened and constricted; bladder distended with urine.

Case 565: Cerebro-Spinal Meningitis.

Emory Wells; private, Company D., 39th Ill. Vols; American; aged 25 years. Entered hospital at Richmond, Va., June 14th, 1865, at 10 o'clock A. M. Comatose; pupils [illegible] dilated; tongue moist, but not furred; pulse 140 to 150; great disposition to tonic spasm; head thrown back; no apparent delirium; eyes congested and suffused; respiration very rapid. This man was apparently well the day before his entrance into the hospital. [illegible] change occurred, and he died at 11:30 P. M., June 15th, 13 hours and 30 minutes after his entrance.

Autopsy, 12 M., June 16th, 1865.—Body emaciated, rigor mortis not well marked.

Head.—Dura-mater greatly injected with blood; no special change in arachnoid; beneath the entire surface of the pia-mater there was a large deposit of thick, yellowish pus. Brain tissue proper infiltrated, greatly congested, and very much softened—a slight stream of water could wash it away. Pus found distributed in patches over the whole brain and in its [illegible] beneath the pia-mater. The right and left ventricles were full of bloody serum, which was flaky with pus corpuscles. The third and fourth ventricles presented the same appearance. Medulla oblongata and cervical portion of spinal cord infiltrated with pus.

Thoracic and abdominal organs normal, with exception of kidneys, which showed a [illegible] fatty degeneration.

Case 566: Cerebro-Spinal Meningitis.

Dennis Brow; private, Company M, 4th Mass. Cav.; age 26. Entered hospital February 19th, 1865. When first seen, was suffering with severe chill; delirious; [illegible] dyspnœa, tongue red, with brown centre; pupils natural; skin dry and moist; pulse [illegible] perceptible at wrist, very frequent and irregular, 120 to 150; eyes red and highly injected; diarrhœa, with involuntary discharges from bowels; [respiration short and quick; respiratory murmur clear and distinct; no cough; very restless, with some tenderness over abdomen; purpura hemorrhagica appeared in spots over the whole surface of the body; indisposed to talk, and it is with great difficulty that he can be made to answer questions. [illegible] good health up to the day before entering hospital.

February 20th, A. M.—Wandering of mind, and disposition to talk; increase of purpura over body; breathing more natural; pulse imperceptible at wrist; skin cool and moist; pupils enlarged; vomiting; diarrhœa; whole surface of skin hyperæsthetic. The patient gradually sank, and died at 2:30 o'clock P. M.

Autopsy, 11 o'clock A. M., February 21st, 1865.—*Brain.* The dura-mater presented [illegible] discoloration over the whole of the superior surface, considerable effusion beneath it; arachnoid somewhat thickened; pia-mater extensively congested with blood, with here and there a thick purplish streak, pus found in patches over the whole extent, lateral ventricles full of bloody serum; thick pus over optic tract; the cerebellum presented the same appearance; there was pus in the fourth ventricle and in the spinal canal.

Chest.—Right lung closely adherent to the pleura costalis; and the pleura of both lungs presents a mottled appearance; lung tissue healthy; pericardium greatly congested and spotted, with thick, purple streaks of congestion. Pericardium contained two ounces of serum, largely mixed with pus. The heart itself is mottled, and is covered with large patches of pus, especially around the sinuses of the aorta. The muscular tissue of the heart condensed, cutting like cartilage. Left ventricle contained one ounce of thin, bloody serum.

Abdomen.—The liver, both externally and internally presents patches of congestion; a small ulcer was found in the left lobe; substance of liver greatly softened. Spleen [illegible] larger than normal. Kidneys normal.

Intestines.—The whole tract was covered with the hæmorrhagic spots; otherwise [illegible] Bladder full of urine.

Case 567: Cerebro-Spinal Meningitis.

William Statten; American; age 21; private, Company C., 15th West Va. Vols. Admitted February 26th, 1865. High fever; pulse 120; delirious and restless; pupils could not be aroused or made to understand anything; petechial spots present over the whole surface of the body, but most marked over the chest and abdomen; vomiting every half hour. Died comatose at 12 o'clock noon, February 28th, without any change in the symptoms.

Autopsy, 10 o'clock P. M., March 1st, 1865.—Body emaciated; rigor-mortis well marked.

Brain.—The pia-mater over the whole surface of the cerebrum, was covered with a thick deposition of lymph and pus; brain tissue greatly congested; base of brain covered in patches with thick yellow pus; pons-varolii covered with pus in large quantity; brain softened throughout its whole extent, and the convolutions were full of serum and pus; one drachm of bloody serum was found in each lateral ventricle; the membranes of the cord were infiltrated with pus, and some two ounces were collected in a cup, on section of the cord, through the lower cervical region.

Case 568: Cerebro-Spinal Meningitis.

F. M. Dwyre; American; aged 23; private, Company C. 9th Maine Vols. Admitted Jan. 15th, 1865, with high fever; pulse 120; severe pain in the back; tongue brown and dry; some epistaxis; urine high colored, with thick phosphatic deposit; eyes injected; pupils contracted; the skin has a jaundiced appearance, and is dry and harsh. Soon after admission, he became delirious, and so continued, without lucid intervals, until death.

For the first three days there was retention of urine. The catheter was used. The urine was high colored; had a strong smell, and deposited a heavy reddish sediment. On the fourth day the urine became more free, of light color, and passed naturally. The pupils remained contracted; some trismus manifest; also difficulty in deglutition.

Fifth day, some jactitation manifest; hearing and vision very obtuse. Patient continued in about the same state, with no other very noticeable symptoms, until January 24th, when he died.

Autopsy, 12 o'clock M., 25th, 1865.—Body greatly emaciated, and the skin very yellow throughout its whole extent.

Dura-mater intensely congested; pia-mater covered with lymph, with here and there patches of pus; the cerebrum was considerably softened in places; large quantities of pus were found covering the base of the cerebellum, medulla oblongata, and optic tract; the membranes of the cord were distended with serum, some pus also was found in them; the cerebellum was very soft, almost disorganized; the lateral ventricles were full of bloody serum, with pus in cornua.

Chest.—Right lung healthy; left lung found to be undergoing hepatization; lymph was found suffused over its entire surface, and adhesions had commenced forming to the pleura costalis.

Heart.—Some effusion in the pericardium, organ otherwise normal.

Abdomen.—Liver fully one-third larger than natural, and its entire surface beautifully mottled; the gall-bladder was quite empty; substance of liver quite soft, and one could easily push the finger through it. Spleen and kidneys normal. Stomach and transverse colon inflated. Three inches of the ileum intussuscepted in one place, and four inches in another The vessels of the whole intestinal tract were injected; glands of the mesentery enlarged.

Case 569: Cerebro-Spinal Meningitis.

Joshua J. Drake; private, Company H, 199th Regiment Pa. Vols.; age 26 years; American; entered hospital January 18th, 1865. Tongue dry and brown; teeth encrusted with sordes; pulse full and rapid, 120 in the minute; great subsultus tendinum; furious delirium; an occasional cough; pupils natural; urine scant and high colored.

The subsultus increased, with tendency to opisthotonos; some epistaxis; eyes injected; coma-like stupor.

Died January 22d, 8 o'clock P. M.

Autopsy, 1 o'clock, P. M., January, 23d, 1865.

Body emaciated; some discoloration about abdomen; the toes of each foot look blue.

Brain.—Dura-mater highly engorged; some effusion between pia-mater and brain; slight exudation of the lymph over the cerebrum and some effusion in the convolutions, with corpuscles of pus; substance of cerebrum softened; no effusion found in the ventricles; membranes of the cord distended with serum; cerebellum covered with lymph; slight exudation of pus, over optic tract.

Chest.—Upper lobe of left lung consolidated; lower lobe highly congested. Right lung shows a highly inflamed condition, and on cutting into the tissue, pus exudes. *Heart*—Pericordium contains eight ounces of serum; slight pericarditis manifest; blood in ventricles not coagulated; the right auricle contains a fibrinous clot.

Abdomen.—Liver enlarged one-third; gall-bladder enormously distended; substance of liver apparently healthy; spleen weighs 1½ lbs.; kidney, normal.

Case 570: Cerebro-Spinal Meningitis.

David Small, Co. I, 9th Maine Vols., aged 16 years, American. Admitted to hospital, Jan. 18th, 1865. On admission there was well marked eruption of rubeola; skin hot and dry; pulse 120; some cough; tongue red and dry, especially through the centre; pupils natural; no delirium; respiration very hurried, and patient seemed stupid. The patient became delirious; pupils contracted; tendency to opisthotonos. Died January 23d, at 9:30 A. M.

Sectio Cadav, 12 o'clock, M., January 23d. Body extremely emaciated—rigor mortis well marked.

Brain.—Membranes engorged with blood. Extensive deposition of lymph beneath arachnoid membrane. Sulci of brain filled with serum. Six drachms of serum found in left lateral ventricle; none found in the right. Cerebellum and pons varolii softened. Some pus found around optic commissure. Pons varolii softened.

Chest.—Four ounces of serum in the pleural cavity. Lower lobe of right lung hepatized; false membrane is forming over posterior surface. On cutting into the substance of the lower lobe, pus exudes. Left lung normal. *Heart.*—Pericardium contains four ounces of serum; heart atrophied and the muscular tissue much softened.

Abdomen.—Liver one-third larger than normal, and greatly congested. Intussusception of ileum for eight inches, old in character. Whole intestinal tract engorged with blood.

Case 571: Cerebro-Spinal Meningitis.

Arthur Smith, aged 23, private, Co. G, 7th Conn. Vols., admitted to hospital, January 6th, 1864; taken with a chill followed by fever; complained of soreness throughout his whole body; vomiting. No change in symptoms, until just prior to death, when he became delirious; pupils dilated and had tonic spasm. Died comatose, 12 M., January 22d.

Sectio Cadav, 4 P. M., January 22d. Body slightly emaciated; rigor mortis, but well marked.

Brain—Dura-mater distended with serum; substance of brain greatly congested with exudation of pus over its whole surface; cerebrum softened; cerebellum so very soft, that a stream of water disorganized it; no effusion within ventricles; spinal cord congested.

Chest.—Right lung normal; left lung congested; and lymph in upper lobe. Pericardium contained eight ounces of serum.

Abdomen.—Liver hypertrophied; gall-bladder distended. Small intestines congested; patches of ulceration found throughout the whole tract of the ileum. Spleen somewhat enlarged.

Case 572: Cerebro-Spinal Meningitis.

John Hughes, private, Co. G. 158th New York Vols., American, aged 24; admitted to hospital, December 22d, 1864. Face flushed; respiration hurried, and talks incoherently—cannot be roused; pulse 120 and full; skin hot and dry; tongue slightly coated; some disposition to tonic spasm.

December 23d, continues unconscious; some spasm of flexor muscles. Semi-delirium. Pupil of eye contracted. Died December 24th, 10 A. M.

Sectio Cadav. Seventeen hours after death. Body slightly emaciated, but presents good muscular development. Rigor-mortis well marked.

Head.—Membranes of Brain present a highly congested appearance; Cerebellum intensely congested, and at its base the sub-arachnoid cavity was covered with a soft yellow exudation presenting every appearance of purulent matter. Cerebellum softened. On removal of the brain, a turbid stream, to the amount of one and a half fluidounces, was found in the occipital fossa, containing pus corpuscles. On the left hemisphere and near the longitudinal sinus, the arachnoid was raised from the brain, by a collection of turbid serum, about ℥ss in quantity. Each of the lateral ventricles contained one fluidrachm of milky serum. Spinal cord congested throughout its length, but no exudations were apparent.

Thoracic and abdominal organs normal.

Case 573: Cerebro-Spinal Meningitis.

H. Manshur, private, Co. E, 2d N. H. Vol. Infantry. Admitted to hospital, February 6th, 1865. This man had been sick in the Regimental Hospital, two weeks prior to his entry; had chill followed by fever; also had diarrhœa. On day of his admission, was delirious, pupils contracted; tongue dry and discolored; respiration hurried, pulse 130.

February 7th. Continues delirious; appears to be suffering greatly; had several involuntary dejections from bowels during night; some spasms of the muscles and disposition to trismus. February 9th. Pupils of eyes dilated; well marked tetanic spasm; cannot force open the jaws—well marked opisthotonos; abdominal muscles hard and rigid; some appearance of petechiæ over body; hands and feet purplish in color, and very cold.

February 10th. Died this morning.

Autopsy 10 *hours after death.—Brain.* The membranes of the Brain, appeared distended and puffed up with fluid, except the pia-mater, which was closely adherent to the brain; convolutions of the cerebrum were covered with lymph, and in some places there were large patches of pus; f℥i. of flaky serum found in each of the lateral ventricles; substance of brain, much softened. The cerebellum presented the same appearances. Membranes of the cord, infiltrated with serum. Patches of ulceration in Ileum.

Case 574: Cerebro-Spinal Meningitis.

J. R. Spellen, private, Co. H, 199th Penn. Vols., American, aged 26 years; admitted to hospital, February 26th. High fever; pulse 120; tongue furred; skin dry and hot; respiration hurried with considerable cough; eyes injected and watery. February 27th. Complains of some pain and jactitation. March 1st, died.

Autopsy 24 *hours after death.*—Body emaciated. Rigor-mortis well marked.

Brain.—On removal of the brain from the skull, f℥ii. of serum was found in the occipital fossa. Great effusion beneath the arachnoid, which was considerably thickened; pia-mater extensively congested with both arterial and venous blood; lymph found in abundance over whole surface of cerebrum and cerebellum, but no pus. No serum found in the ventricles; brain tissue very much softened. Spinal cord not examined.

Chest.—Lungs normal; considerable effusion found within the pericardium; right auricle and ventricle filled with coagulated blood; large fibrinous clot found in left ventricle.

Liver and kidneys normal. Spleen atrophied. Intestines congested and spotted.

Case 575: Cerebro-Spinal Meningitis.

G. W. Bean, private, Co. C., 9th Maine Vols.; American; age 24. Admitted January 16th, 1865, with what was considered a well marked eruption of rubrola; slight fever; pulse 98; severe cough with pneumonic expectoration; severe pain in right side and considerable dyspnœa; tongue red and dry. Eruption had made its appearance three days before his entrance. Made complaint of severe pain in his head and down his back. Pupils of eyes natural. The man became delirions on the third day after his entrance, and continued insensible until the date of death, which occurred January 31st, at 3:30 o'clock, A. M.

Autopsy, 2 o'clock, M. Body greatly emaciated; rigor-mortis well marked.

Brain.—Membrane greatly congested and distended with serum; arachnoid thickened; patches of lymph over surface of cerebrum and cerebellum. No effusion found in the ventricles; some little pus found over tract of optic commissure. Membranes of cord infiltrated. Brain tissue softened.

Chest.—Upper lobe, and portion of lower lobe hepatized (red).

Abdomen.—Liver enlarged one-third, and mottled.

Case 576: Cerebro-Spinal Meningitis.

James Kirkpatrick, private; Co. C. 199th Pa. Vols. Admitted to hospital January 20th, 1865. Died February 2d, 1865.

Autopsy, 12 hours after death. *Brain.*—Considerable effusion under the membranes, and dura-mater in a high state of congestion; arachnoid thickened. Over right hemisphere of cerebrum there was a large deposition of lymph; pia-mater thickened, and adherent in some places to the brain. Pus found in small quantities over optic tract. Ventricles partly filled with turbid serum; brain tissue soft and cavity broken down; spinal cord much congested.

Case 577: Cerebro-Spinal Meningitis.

Samuel Farnsworth, private, Co. H. 10th N. H. Vols. Admitted to hospital, December 21st, with masked fever; pulse 120; tongue thickly coated; skin dry and burning; difficult respiration; diarrhœa with involuntary discharges; severe cough with free expectoration; constant pain ascribed to back of head and neck; urine voided freely, but of dark color. December 22d, more obtuse, pupils natural; pain in back continues; discharges from bowels quite frequent; December 24th, died comatose, at 10 P. M.

Sectio Cadav., twelve hours after death. *Brain.*—Dura-mater intensely congested, with some effusion beneath it; some lymph deposited over the lobes of the cerebellum; ventricles dry; brain tissue softened; meninges of cord congested through cervical region.

Chest.—Double Pleuro-Pneumonia. Heart normal. Liver, spleen and kidneys healthy.

During the months of January, February and March, 1865, a large number of cases came under the notice of Surgeon Chas. M. Clark, at the field hospital of the 24th Army Corps, which at that time was located near Hutching's Run, Virginia. The troops were comfortably quartered about three miles back from Varina Landing, on the James River. The country was high and rolling, and heavily timbered, the soil being a mixture of sand and clay. The season had been remarkably wet, and intermittent, remittent and "*typho malarial*" fevers were prevailing extensively. The men were also greatly and continuously exposed to fatigue and excitement, there being almost constant calls upon them for duty in reconnoitering, constructing earth-works, and fighting the enemy; and Surgeon Clark considered that it was but fair to presume, that the continual hardship and excitement that the men endured, and withal, considering that they were in a decidedly miasmatic region, were conditions that undoubtedly predisposed to attacks of the malady. The enlargement of the liver and spleen, and the ulcerations of the ileum in some cases, recorded by Surgeon Clark, without doubt, should be referred to the preceding causes and not to the disease under consideration.

It is a matter of regret that a full record of the previous history in each of the foregoing cases (563–577), was not obtained, as it would not only have enhanced the interest attaching to them, but would have been more satisfactory in a practical point of view; the results of post-mortem examinations, however, of those cases, fully and unequivocally sustain the view that Cerebro-Spinal Meningitis is essentially an inflammatory disease of the Cerebro-Spinal Nervous System, and that it may be accompanied by inflammation of the Peri-Cardium, Pleura and Lungs.

In the epidemic of Cerebro-Spinal Meningitis, which prevailed in Philadelphia, during the months of December, 1866, and January, February and March, 1867, according to Dr. W. H. H. Githens, who recorded careful observations upon the cases treated in the Philadelphia Blockley Hospital, the post-mortem examinations revealed similar lesions of the Cerebro-Spinal System. The membranes of the brain were congested, and serum was effused in large quantity in the sub-arachnoidean spaces, at the base of the brain, and within the membranes of the spinal cord. Fibrin was deposited along the margins of the longitudinal fissure of the brain, about the commissure of the optic nerve; in fact, freely over all the base of the brain; and in one case, it could be separated in masses weighing from three to five grains, from where it had firmly glued together the two surfaces of the fissure of Sylvius.

The quantity of this deposit of fibrin, its color, consistence and strength of attachment, were influenced chiefly by two cases observed during life. In some cases, where the inflammatory symptoms were of an active character, as shown by the congestion of the face and eyes, the character of the pulse, and the violence of the delirium, death occurred early; and an autopsy showed little or no deposit of solid lymph, but a large quantity of serum, and in one case pus, in all the serous cavities connected with the brain and spinal cord, with turgescence of all the vessels of the pia-mater and nervous substance. If on the other hand, death did not intervene so quickly, there were deposits of fibrin, becoming larger, firmer, and more adherent, in proportion to the grade of inflammatory action, and the time allowed for its coagulation. These deposits were of the same character as those found in the cavity of the abdomen after an attack of peritonitis. No particular lesion of the cord itself was noticed, the membranes were congested, and there were several deposits of fibrin about the roots of the spinal nerves.

The following cases with post-mortem examinations, are selected from the report of Dr. Githens, in addition to those previously recorded.

Case 578: Cerebro-Spinal Meningitis.

Julia Dilen, æt. 21; was delivered at full time, January 25th, 1867, by means of forceps. January 30th. An eruption of an erythematous nature, appeared on chest with distinct eruption of a darker hue on abdomen and thighs. Vomiting, no pain or tenderness in neck or back, or stiffness of muscles anywhere.

After midnight, a hæmorrhage of about sixteen ounces from uterus occurred.

January 31st, A. M. Vomiting and continued thirst, pulse 130, quick and weak.

10 P. M. Signs of cerebral disturbance; pain in the head with general uneasiness, and vomiting.

February 1st, 10 A. M. Semi-comatose; evidently suffering great pain; face darkly congested; pupils contracted. Pulse quick, 150 beats per minute. Later in the morning, coma deepened; the eyes became dry and rolled upwards; patient comatose, could not be aroused. Died at 3 P. M.

Post-Mortem Examination, eighteen hours after death. Effusion of serum within the membranes of the brain and spinal cord; deposit of fibrin along longitudinal fissure; congestion of the membranes of the brain itself; softening of the brain substance, effusion of serum in pericardial sack. Effusion of about sixteen ounces of serum into cavity of abdomen, with deposit of coagulated fibrin in small amount on uterus, ovaries and descending colon.

Case 579: Cerebro-Spinal Meningitis.

Mary Peterson, æt. 45; temperate; first noticed in a collapse of three hours duration. Symptoms were congestion of eyes; the right pupil contracted, the left dilated and appeared to dilate more under the influence of light. Coma, with labored stertorous respiration; apparently some headache; constipation; no eruption. Pulse 180, very feeble. Skin hot and dry. *Died in forty-three hours.*

Post-mortem Examination, revealed very extensive deposits of fibrin at base of brain; about five ounces of serum at base of brain; spinal cord congested, with deposit of fibrin beneath the arachnoid. A small quantity of pus around the cord in the cervical region.

Case 580: Cerebro-Spinal Meningitis.

Wm. McAllister, æt. 63; temperate; slight headache; alternate constipation and diarrhœa; muscular pains in limbs and back; slight petechial eruption; brown, dry tongue; pulse could not be felt; complicated with double pneumonia. Death on ninth day. Brain lesions were very marked; large masses of closely adherent lymph at base of brain and on medulla oblongata.

Case 581: Cerebro-Spinal Meningitis.

Annie Fitzgerald, æt. 20; temperate. Coma; severe headache; muscular pains in back; pain on pressure, over dorsal vertebræ; conjunctiva slightly congested; thirst intense, tongue dry, brown and furred in centre, but clear at edges; pulse 90 to 160; skin hot and dry just before death. Disease complicated by pre-existing pneumonia of right side; puerperal convulsions. Death by exhaustion on eighth day. Autopsy revealed large quantities of tough adherent lymph; deposits at base of brain.

Case 582: Cerebro-Spinal Meningitis.

Henry Saxe, æt. 68. Muttering delirium; intense headache; constipation; muscular pains in neck, limbs and back; slight opisthotonos; petechial eruption; marked congestion of conjunctiva; severe thirst; tongue dry and brown; pulse 90 to 120. Died on eighth day. Large deposits of fibrin at base of brain. Am. Jour. Med. Sci., July 1867, pp. 17, 34.

Dr. S. J. Webber, in his Essay on Cerebro-Spinal Meningitis, which received the Boylston Medical Prize, (Boston Medical and Surgical Journal, vol. xxv., pp. 59, 61,) affirms that the results of all careful observers, have shown that the principal lesions are found in the brain and spinal cord; the morbid changes varying from slight increase of the number of hæmorrhagic points, to extensive softening of the brain, with effusion of lymph and pus beneath the membranes.

"The arachnoid in some instances has lost its transparency and become opaque, especially at the vertex. Beneath it may be seen the vessels of the pia-mater engorged with blood, that membrane being congested. Between the membranes, there is often an effusion of lymph, pus or serous fluid, which may also extend into the ventricles distending them; lymph occurs more frequently than serum, and is deposited upon the under surface of the cerebrum, cerebellum, pons varolii and medulla oblongata, rather than upon their upper surface, and follows the sulci, nerves and vessels, imbedding them in its substance. Pus is often found in the same situations. The lymph is of a greenish or greenish-yellow color, varying in amount from a thin layer, to nearly half an inch in thickness and in consistency from a dense, almost fibrous membrane, to a soft, semi-liquid substance. The veins and sinuses of the brain, are distended with dark fluid blood. The substance of the brain may be natural in appearance, but it is often congested, the hæmorrhagic points being increased in numbers; it may be softened almost to a pus-like liquid. * * The same congested appearance and softening are found in the cerebellum, pons varolii, and medulla oblongata. * * In the spine, a similar condition may exist, the membranes being congested, there being an effusion of serum, lymph or pus, and the substance of the cord being congested or softened.

The following is a very brief statement of the results recorded by Professor J. S. Jewell, of Chicago, in his report on Cerebro-Spinal Meningitis, based upon the reports of 200 Autopsies which he had collected from various sources. In this disease, post-mortem changes are almost never absent from the cerebro-spinal cavity. Both the cranial and spinal dura-mater, almost never present well-marked evidences of structural change, or of a firm *exudation*, on the free or serous surface. The arachnoid also has not often presented evidence of disease. The pia-mater, unlike the two cerebro-spinal investments, just mentioned, has almost uniformly presented the appearance of disease. Rarely cases have occurred in which no evidence of structural change or exudation have been observed, but *not one* where *congestion* has been absent. The rule is that it presents the most indubitable evidences of disease. Those parts of it most frequently diseased, are at the base of the brain, about the optic commissures; the interpeduncular space behind the commissure; the pons varolii and medulla oblongata; under surface of the cerebellum, and along the fissure of Sylvius. After this, the surface of the hemispheres is the most constant seat of disease. The congestion and the exudation when present may occur uniformly over the surface, or, as invariably happens with the latter, is found along the course of the sinuses and blood-vessels, and large fissures, and along the fissures between the convolutions. Next, the pia-mater of the cervical portion of the cord is most frequently diseased, and of this part and the medulla, the *posterior aspect* is most often diseased. M. Levy found in 44 cases, the posterior part almost exclusively affected in 27 cases.

Next in order, the lumbar and lower part of the dorsal regions are most often affected; and lastly, the pia-mater of the dorsal portion seems most frequently to be free from disease. Sometimes cases have occurred in which the spinal element has been absent, but the converse has been exceedingly rare.

Except in some cases, where death has occurred either with extreme suddenness, or in cases of long standing, there is found to be an increase of the subarachnoid fluid, especially at the base of the brain. In recent cases, it consists in a simple increase of the natural fluid, but in most cases, it is colored yellowish or reddish by pus or blood, and varies in quantity from a few drachms to several ounces. It varies in consistence and has been found by M. Forget almost gelatinous.

Except in those cases where death seems to have taken place too soon to permit of such a result, there has been found more or less plastic exudation, most abundant, in such places as have been already indicated. It may be a soft, friable, pus-like layer, or have a gelatinous consistence, or be firmer yet as coagulated fibrin; it may be nearly transparent, or have a grayish color, or may have a white or creamy appearance, or be tinged various hues, by either pus or blood, or both. It may cover a large extent of surface or be disseminated in patches here and there. But it is always when present, found along the course of the large vessels and the fissures, and about the roots of the nerves, whether the cranial or spinal, the posterior roots of the latter in particular. It is, when present, on the surface of the pia-mater, but may be infiltrated into its structure, or beneath it into the nervous substance for a short distance. It varies in thickness, from a mere film to a line or two, or more. Its consistence depends much on the duration of the case, being most so, in cases which have some duration.

The ventricles of the brain have generally been observed, with more than the normal quantity of fluid in them; occasionally, the quantity has seemed to be normal. It has been found to vary from a small increase to several ounces, and in a case reported by Dr. Reading, the quantity was so great the ventricles were ruptured. M. Toudes, saw in 44 cases examined at Strasbourg, 26 in which the ventricles were distended; and in 44 cases examined by M. Levy, at Val de Grace, 18 presented distended ventricles.

Niemeyer mentions a case, where the ventricles contained as much as six ounces of fluid. The ventricular walls have been found softened, and Allen speaks of having seen ecchymosed spots in them.

The *Nervous substance* in the majority of cases has been reported healthy; occasionally it has been seen paler than natural, more frequently it has been seen congested in various parts and degrees. M. Levy found in 44 cases injection of the nervous substance, 9 times. *Softening* has occasionally been reported in chronic cases; Niemeyer records it in 2 cases out of 15. One of these cases was of 49 days standing, and exhibited cheesy metamorphosis.

The spinal cord, is sometimes congested and softened.

No characteristic or uniform lesions have been observed in the lungs, heart, and abdominal viscera. Report on Cerebro-Spinal Meningitis, Chicago Medical Examiner, October 1866, pp. 609, 617.

As early as 1806, Drs. Danielson and Mann, found adhesions of the cerebral membranes, in two out of five dissections, or "a fluid resembling pus, both over the cerebrum and cerebellum." In all the cases the encephalic veins were turgid with blood.

Drs. Thomas Welsh, James Jackson and John C. Warren, in their elaborate report to the Massachusetts Medical Society, recognized the important distinction between the appearances in two classes of cases; in those which are fatal within the space of twelve hours from the invasion, there is only excessive congestion of the large blood-vessels, but in those which perish at a later period, they discovered other lesions which they described as "more conspicuous in proportion to the duration of the disease." They proceed to observe: "The tunica arachnoides and the pia-mater are remarkably altered in appearance by the effusion of an opaque substance between them, which may be called coagulable lymph or semi-purulent lymph. This substance is frequently of the yellowish color of pus, with a consistency between the tenacity of lymph and the fluidity of pus. At other times we see it possessed of the aspect of well characterized lymph. The membranes at the base present the same appearances as at the vertex of the brain. *"

Dr. Joseph A. Gallup, in his "Sketches of Epidemical Diseases in the State of Vermont, published in Boston, 1815," gives an accurate account of Cerebro-Spinal Meningitis under the name of Spotted Fever, and devotes an entire section to the *appearances after death* and on dissection. Dr. Gallup appears to have been fully acquainted with the characteristic lesions; thus he says:

> "The blood-vessels in the brain, more especially the veins, are very turgid. The small vessels are injected with red blood, which in a state of health are destitute of it. The membranes of the brain exhibit different degrees of inflammation, according to the term of sickness and degree of local affection in the brain. Signs of inflammation are discoverable in almost the whole of the brain; the dura-mater adheres more strongly than natural to the cranium; also the brain beneath often adheres to its meninges. An increase of serous fluid is often discovered between the membranes, and the ventricles are more or less filled with the same, as in hydrocephalus. The anterior and inferior parts of the brain exhibit the greatest marks of violence, and everywhere a remarkable pressure in the veins."

Dr. Gallup records the histories and Post-Mortems of several cases, illustrating fully the symptoms, and the characteristic lesions of the Cerebro-Spinal System in this disease, which at that time was called Spotted Fever. He quotes a case from Dr. Bowen of Reading, to show, "that actual inflammation exists in the head even to the suppurative process." He describes the characteristic effusion of the pia-mater in several cases, and calls it pus.—Sketches of Epidemic Diseases, in the State of Vermont, etc., pp. 236–243.

After careful examination of the work of Dr. Hale on "Spotted Fever," I find that this author had made no post-mortem examination himself, and appears to have been ignorant of the results obtained by other observers.

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* This Committee was appointed by the Counsellors of the Massachusetts Medical Society, March 27th, 1810, and their Report is given in the Massachusetts Medical Communications, Vol. 2, Boston, 1813.

Dr. Job Wilson, in his work, published at Boston in 1815, not only describes the nervous derangement observed during life, but also gives drawings representing the appearances found after death, in the brain and appendages.

Drs. North, Woodward, Fish and Miner, all directed, in their observations upon Spotted Fever, published about this time, attention to the nervous disturbances, the persistent dilatation or contraction of the pupils of the eyes, various disturbances of vision, drawing back of head, clonic spasms of the muscles of the neck, pain and rigidity of the muscles, numbness or total insensibility and paralysis in various parts of the body, shifting pains and spasms, anæsthesia and paralysis, and hyperæsthesia of various parts, blindness, deafness, loss of sense of taste, spasmodic deglutition, and paralysis of the pharnyx. The last named author, after giving a case which he describes as stupid as a block, unconscious of any impressions on either of the senses, and so convulsed that it required three or four men to hold him on his bed; with eyes open and rolled back so as to hide the colored part, and with teeth firmly clinched as in locked-jaw, and with face, arms and legs, and body literally covered with spots: Dr. Miner remarks, "Spotted fever appears to have its seat and throne in the brain, to belong nosologically to the passive phlegmasiæ."

Dr. S. Ames, of Montgomery, Alabama, appears to have been the first author in this country, who after an interval of thirty years accurately investigated and described the symptoms and anatomical lesions of Cerebro-Spinal Meningitis. The admirable paper of this careful and accomplished medical observer, embraced an account of eighty-five cases, sixty-four of which were subjected to a regular analysis. According to Dr. Ames, 250 cases occurred during the winter and spring of 1848, in the town of Montgomery, Alabama, which had a population of about four thousand.

Dr. Ames considered the term Cerebro-Spinal Meningitis, not strictly applicable to the epidemic described by him; the symptoms and morbid anatomy of the malignant forms especially, showing that the substance of the brain, if not the spinal marrow, was almost invariably involved. He believed that there were good reasons for supposing that the same was the case in the epidemic form of the disease, as it occurred in France. Thus M. M. Toudes and Forget, mention the existence of hyperæmia of the brain, in every instance in which the condition of that organ is noticed. While the occasional observation of one of the products of inflammation, viz: softening, and in all the fatal cases the occurrence of symptoms, such as abnormal sensibility and muscular motions, delirium, coma, &c., which, being observed in a disease having a constant excess of fibrin in the blood, may be considered as unequivocal evidence of inflammation of the nervous substance—at least, so long as there is no proof that simple meningitis can produce them. The symptoms indicating serious and undoubted lesions of the brain and spinal cord, as described by Dr. Ames, were of the most unequivocal character—cephalagia, (some described the pain in the head as a continual, painful roaring, others as a fulness and tightness, as though a band were tightly drawn around the head, or as if the forehead, crown or sides, were being crushed inwards; a greater number described it as darting and throbbing, frequent shooting through the head from behind forwards, and from side to side with a violence causing the patient to cry out); giddiness in the first few hours of the attack; injected conjunctivæ, with glittering, watery eyes; the pupils were dilated in seven out of forty-one cases, in the others they were either contracted or natural, in three cases they were insensible to light from coma, and in two without loss of consciousness; double vision occurred in six cases, photophobia in six cases, in a number of others the ordinary light was disagreeable; in one patient, the sense of smell was lost in one nostril, in some cases there was spontaneous deafness, and in one case the deafness occurred three times on the second day, each time lasting about three hours, with intermissions of about the same duration; stupor, amounting generally to profound coma, which did not remit in the cases which proved rapidly fatal, but which in other cases alternated with delirium, and in favorable cases with lucid intervals;

tonic contraction of the muscles of the back and neck, tonic spasms of the muscles and in some patients tremors, twitchings and perpetual motions of the limbs, in some cases trismus, in a few opisthotonos, but in the majority the extremities of the spine were thrown backwards till it was bent like a bow constituting opisthotonos; general convulsions in a number of cases; strabismus occurred in nine cases, an incomplete paralysis of the right eyelid occurred in one case, and of one entire side of the body in another; pain in the muscles in various parts of the body along the whole length of the spine, and in the muscles and joints of the extremities, in some patients; this pain was of the acutest kind, and there was such a general morbid sensibility that the slightest touch would make the patient start with a general spasm and scream out with pain; pressure applied to the cervical portion of the spine produced pain in the head, frequently darting to the forehead, eyes and temples.

Dr. Ames drew up his account of the *anatomical character* of this disease, from notes taken in eleven cases, and the following summary presents a general view of the results obtained by this observer.

Brain.—The dura-mater was the seat of abnormal vascularity in two cases. The pia-mater exhibited abnormal vascularity in every case. The vessels carrying the convolutions were uniformly red, numerous, and large in size; in several instances, many of them were a line, or even more in diameter. In different subjects, spots of red ecchymosis were observed on the lateral walls of the third ventricle, the anterior wall of the fourth, and in the posterior horn of the left lateral ventricle. They were also seen, in several cases, on the upper surface of the hemispheres, and on the cerebellum. On cutting into the substance of the brain, besides the red points commonly present in cases of congestion and inflammation, there was invariably found an infinite number of red vessels containing, sometimes fluid, at others, coagulated blood. The gray and white matter had a pink color, dependent upon the presence of vessels that were separately visible—which, although never entirely absent, occupied different parts in different subjects. In two cases, the medulla oblongata was spotted interiorly with dark, ecchymosed spots. Of these alterations, the cerebellum partook, to a greater or less extent, in every case. Circumscribed portions of the membrane were softened in seven cases; in four, on the exterior of the brain, including the inferior surface of the cerebellum; and in the remaining three, on the floor of the lateral ventricle.

In nine cases, the brain itself was softened; in seven, in some parts of the hemisphere, chiefly in the cortical; in three, in the medulla oblongata and pons varolii; in five, in the fornix and septum lucidum; in one, in the walls of the third ventricle and canal leading to the fourth; in another, in the corpus callosum and outer semi-circular rim of the left corpus striatum; in another, in the optic nerves, the commissure, and the tractus opticus; in two cases, in the crus cerebri, and in one, in the cerebellum.

In ten cases, there was an effusion of yellowish colored matter, showing, under the microscope, an abundance of pus and lymph globules, on some portion of the membranes covering the exterior surface of the brain. In the greater number, enough of the effused lymph was coagulated to give some cohesiveness to the morbid product, but not enough to give it the appearance of an organized membrane. In appearance, it resembled a very loose coagulum of fibrin. It was always found beneath the arachnoid membrane. In some cases it was so diffused as to look like a coating of cream upon the hemispheres; in others, it was confined, on the convex surface of the hemispheres, to the course of the large vessels between the convolutions. At the base of the brain it was in the greatest quantity, and met with most frequently about the optic commissure—it was here never absent. In one case, it was found only at this point—the interstices of the convolutions being occupied by a serous fluid, containing a few pus globules. It was found also on the corpora quadrigemina, the medulla oblongata, and around the third pair of nerves, where they penetrate the arachnoid membrane. The exterior surface of the cerebellum was frequently the seat of this deposit.

In nine cases, there was an effusion of fluid into the arachnoid cavity. With this effusion, pus globules were mixed, in various proportions, in every case in which they were sought. In two cases, the effusion consisted chiefly of pus, mixed with globules. In the case in which the arachnoid membrane had a pink color, a quantity of the effused fluid, after standing a short time, coagulated. In one case, cranial portion of the arachnoid was the seat of an organized false membrane.

In four cases, a morbid effusion was found in the lateral ventricles; in one, it sisted of a cream-colored layer, semi-fluid, on a part of the left corpus striatum; another, there was about a drachm of a greenish colored pus; in another, serum from flocculi; and in another, serum mixed with pus and blood.

Concrete fibrin was found in the vessels of the brain, in several cases, viz: in internal carotids, in two: in the basilar artery, in one, and in the longitudinal sinus veins leading to it, in one; the concretion in this case occupied the entire length of large vessel, and extended from it into the small vessels, from which threads of were drawn out to the length of several inches.

Spinal Cord.—So far as the spinal cord was examined, the lesions, generally sp ing, were the same as those met with in the brain, in the same cases. The in vascularity of the pia-mater was always present, but the lympho-purulent deposit, a the injection of the cord proper, were less common than in the brain.

In other parts of the body no lesions were observed, which seemed to be other th accidental, or particularly worthy of note, except those found in the digestive tube, a mesenteric glands.

The abdomen was opened in five cases; in all of them the mucous membrane of t stomach and ileum was reddened, thickened and softened to a greater or less extent. four cases, there were lesions of the agminated, solitary and mesenteric glands. T solitary and agminated glands were enlarged, and in one case ulcerated. The mes teric glands were enlarged, red, and in one case softened.

Blood.—The blood taken from the arm, and, by cups, from the back of the presented some physical characters, which, considering the nature of the disease, w peculiar, and sufficiently uniform to assist in the diagnosis of some equivocal cases. coagulated with great rapidity. The serum separated from it very slowly, and in s quantity. Its color was generally bright—in a few cases nearly approaching to that arterial blood; it was seldom buffed; in thirty-seven cases in which its appearance noted, it was buffed in only four. The blood, an analysis of which is given below, taken, early in the disease, from the arm, and was the first bleeding in each case. first was from a laboring man, thirty-five years old; the second from a boy of tw years old, while comatose, and the two others from stout women, between thirty thirty-five.

COMPOSITION OF THE BLOOD IN CEREBRO-SPINAL MENINGITIS.

	(1.)	(2.)	(3.)
Specific Gravity of Defibrinated blood	1053.50	1046.	1046.50
" " Serum	1026.	1022.	1024.
Water	767.87	813.83	796.07
Solid Contents	232.17	186.17	203.83
Fibrin	6.40	5.20	3.64
Corpuscles	140.29	112.79	123.45
Solid Residue of Serum	85.31	68.10	76.84

New Orleans Medical and Surgical Journal, November, 1848, Vol. v, No 295–328.

In those cases of Cerebro-Spinal Meningitis in which death occurs suddenly a short period after the first manifestations of nervous derangement, no marks of the cerebro-spinal nervous system is found, beyond congestion. The absen deposit of lymph, and of the unequivocal marks of inflammation in the cere axis, led to many erroneous speculations, with reference to the nature of the d

Dr. W. W. Gerhard, of Philadelphia, has recorded the following observa this disease, which he terms Spotted Fever, and which he attempts to throw class of essential fevers:

the middle of last February, (1863), I was called to a case of a new form of dis-

> 83.—The patient, a boy of sixteen years of age, was taken suddenly with intense
> head and back, with occasional delirium; there was also vomiting and nausea.
> rvals of the delirium, he was dull and heavy, but able to answer questions cor-
> the second day, there was an eruption over the whole body, of spots varying in
> such as would be caused by the prick of a pin, to an inch or more in breadth.
> s were of a dull red color, not in the slightest degree elevated, and rather resem-
> moses, such as might be caused by the puncture of an insect, than a proper erup-
> re was no diarrhœa, moderate heat and fever; the tongue was scarcely coated.
> t died in four days from the attack, sinking into a state of coma.
> 84.—A sister of this patient, aged twenty, was taken ill and died in twenty-six
> the commencement. She was attended by Dr. Packard, and had an eruption
> ll respects to that of the other patient during life. On examination, after death,
> ive lesion was found.
> days after these occurrences, I was called to the Falls of Schuylkill, five miles out
> to see a number of cases of a new form of disease, which had excited much alarm
> hborhood. * * It was in that locality exceedingly fatal. * * Of the whole
> thirty, ten terminated fatally. Unfortunately, no examination after death was
> in any of these cases, notwithstanding the most urgent entreaties.
> n examination of the symptoms of a number of these cases, and comparing them
> ne I had already seen in Philadelphia, I was enabled to make out the character of
> on, which, never having been met with before in Philadelphia, was entirely novel
> hysicians. The disease is unknown in Europe, and is not even mentioned in the
> work of Dr. Wood, or in any other one I believe, on the Practice of Medicine.
> ccount of it to be found, is an imperfect description given of it by a number of
> in New England, where the disease appeared more than half a century ago, from
> 07 to 1815 or 1816."

W. Gerhard, under the head of *Anatomical Lesions*, gives the report of the
mortem examination of what he calls "Spotted Fever." which had come
der his observation. Thus he says:

> se in Montauk, a patient of Dr. Uhler, I was enabled to see the autopsy of the
> y. The brain was found to be congested with blood, the veins containing an
> antity of it. At the base of the brain was an effusion of a few ounces of serum;
> les of the brain contained a moderate quantity of serum, but there was not a
> y lesion produced by inflammation."

ns of note were found in the other organs.

is very slender foundation, viz: one post-mortem, by Dr. Packard, the sub-
g died in the first stages of the disease, twenty-six hours from the commence-
one post-mortem witnessed by Dr. Gerhard himself, the subject being a
another physician, and in a different locality, and the account, as recorded,
y history of the case, this distinguished pathologist boldly announces the
t Spotted Fever "is strictly a blood disorder, unconnected with any structural
Dr. Gerhard, by his own admission, was ignorant of the important and
monograph of Ames, of Montgomery, Alabama, and he passes over the labors
nielson and Mann, Drs. Thomas Welsh, James Jackson and John C. War-
oseph A. Gallup, Drs. Hale, Wilson. North, Woodward, Fish and Minor,
remark that "the only account of Spotted Fever, (Cerebro-Spinal Menin-
to be found in an imperfect description given of it by a number of physicians
gland, where the disease appeared more than half a century ago, from the
to 1815 or 1816."

tely after recording the post-mortem examination above given, Dr. Gerhard

> tomical lesions thus confirmed the conclusions at which I had already arrived
> the pathology of the disease. That is, that it is strictly a blood disorder, uncon-
> any structural lesion. The internal ecchymoses of blood are precisely similar
> on the skin,, and are evidently depending on the same cause. This fact estab-
> le distinction between them and those appearing in Typhus or Typhoid Fevers, as
> eruptions of the exanthemata.

It requires nothing but actual observation to entirely dissipate all such ideas. Th ease belongs to the same class as other continued fevers, or exanthemata, but is just tinct from Typhoid, or Typhus Fever, as from Measles or Small-Pox. The two which it has the closest similarity, are the Petechial Typhus Fever, and some varieties of Scarlatina.

Dr. Gerhard even goes so far as to congratulate himself in being thus able to " lish the character of another variety of febrile disorder." Thus he says:

"In the year 1836, I was first led to study the diagnostic characters of Typhus, and down the distinctive characters separating it from Typhoid Fevers. (Am. Jour. Med. 1837). These are now adopted by all the physicians of the French school, and by a number of English observers; I could not help, therefore, regarding it a most fortunate cumstance, that accident had afforded me an occasion for establishing the characters another variety of febrile disorder, which, although not so common as either Typhus Typhoid Fever, is yet more fatal in its symptoms and course. These three varieties of I regard as more distinct than many cases of Intermittent and Remittent; although sionally the distinctive characters may be somewhat confused one with another, yet, whole, they are so well defined, that no legitimate excuse can exist for confounding them with another. The diagnosis of the Spotted Fever is, however, much better defined that of Typhus and Typhoid, in all cases, for sometimes these approach so nearly in symptoms, as to render the diagnosis of them very difficult." Spotted Fever occurring in vicinity of Philadelphia, in the year 1863. Quarterly Summary of the Transactions of College of Physicians of Philadelphia, 1862-1864, pp. 41-49.

Dr. Gerhard was evidently led into error as to the nature and characteristic of "Spotted Fever," by making a hasty generalization upon the results of two mortem examinations; and it is very evident that he had not critically examined authorities on the disease; for if he had studied the "*imperfect description* given of by a number of physicians in New England," he would have found that the theory recently and so warmly advocated by himself and other physicians of Philadelphia, Cerebro-Spinal Meningitis ("Spotted Fever,") is an essential fever, closely allied Typhus Fever, was propounded half a century ago.

Thus, Dr. E. Hale, in his History and Description of an Epidemic Fever, com called Spotted Fever, which prevailed at Gardiner, Maine, in the spring of 1814, his discussion of the nature of the disease, says:

"The whole inquiry, then, is into the nature and character of the fever as such.

"It has become customary to give the name *Typhus* to all fevers in which prostration and exhaustion are prominent symptoms, however various these characters in other respects. If this is to be regarded as a general distinction, merely expressive of the debility which accompanies fever, it obviously includes the disease which is described in the preceding page. But if Typhus is to be considered as a particular disease, the fever under consideration was not a Typhus; for it did not exhibit the characteristic symptoms which belong to that ease. It had not the regular approach, nor the uniform appearance of Typhus. Its progress was more rapid, its features more variable, its changes more abrupt, and its termination sudden.

"These are obviously characters of different diseases; and in practice, nothing easier than to distinguish them. A very slight examination is sufficient to show that we met a very different fever from that which has been so long known as Typhus.

"Yet this was a disease of debility, and of very great debility. I am aware of the tion between mere prostration of strength and debility. The fever under consid exhibited them both, and in a very powerful degree. The strength was not only oppressed the impulse of the disease, but it was rapidly exhausted. To adopt the comparison of dyce, the spring was not only overpowered, so as to prevent its action, but its elast speedily vanished under the weight which pressed upon it. * *

"I have thus applied to the epidemic under consideration, the distinction which Armstrong has adopted in his illustrations of Typhus. There are many points in which two diseases resemble each other, yet there are others, equally important, in which they dently differ. Several of these have been mentioned. There is one other circumstance difference, deserving of notice, which was omitted there, because its correctness may haps, be universally allowed, without further illustration. Typhus is everywhere as a contagious disease, while the epidemic which has so extensively ravaged our generally believed not to be contagious.

> "This is fully my opinion, and so generally is it established, that I should not think it necessary to say anything in its support, were it not that the contrary opinion is held by some gentlemen for whom I have a high respect." Chapter vi, pp. 226, 227, 240.

Dr. Jewell and Dr. W. H. H. Githens, of Philadelphia, have recorded observations, which demonstrate that the characteristic lesions of the cerebro-spinal system are present even in those cases which terminate fatally in the first stages of the disease, and within 48 hours after its onset.

Similar views to those advanced by Dr. Gerhard were advanced by the committee appointed by the American Medical Association, (Trans. Med. Association, Vol. 17, 1866, pp. 333–336), to report on "Spotted Fever," so-called.

Thus, the chairman of this committee, Dr. James J. Levick of Philadelphia, says:

> "A careful examination of the subject has left no doubt in the minds of the committee, that the disease is essentially a fever, not essentially an inflammation; that local inflammations, when they do occur, are consecutive to the constitutional disturbance, are due to the morbid condition of the blood, provoking exudation, and that their locality is determined by incidental circumstances. In the large majority of cases, the brain, with its appendages, is especially involved. Next in frequency, in the order in which they are named, will be found the exudations in the lungs, the peri, and endo-cardium, and the synovial cavities. In some epidemics there would seem to be a similar tendency to exudation in the lining membrane of the larynx and pharynx."

After discussing the question of the relations of Cerebro-Spinal Meningitis with Typhus Fever, the conclusion is reached, that:

> "Whilst holding the opinion that Spotted Fever is a distinct disease, due to a specific cause, and having its own mode of invasion, phenomena and course, the committee wish again to state their conviction of its close analogy to Typhus Fever.

In the two instances reported by Dr. Levick, (Am. Jour. Med. Sci., July, 1864, and July, 1865), one an adult female, and the other a child aged eighteen months, both of whom died in twelve and fourteen hours after the seizure, in the midst of health, the cerebro-spinal meninges were filled with black blood. The account is imperfect, because it is not stated whether there was opalescence or unnatural dryness of the membranes, and the statement that "there were no traces of inflammation, and the substance of the brain and medulla oblongata was natural in appearance and consistence," amounts to no more than this, that fibrinous effusion had not then taken place, because a sufficient length of time had not elapsed. As congestion is an essential element of inflammation, and, in fact, is its starting point, the cases of sudden death in the first stages of Cerebro-Spinal Meningitis, in which the membranes of the cerebro-spinal system have been found to be congested with black blood, furnish no grounds whatever for the theory that the disease is an essential fever. If patients die in the first or congestive stage of pneumonia, before any of the products of inflammation have been formed, we are not justified by such superficial observation in classifying this disease with the essential fevers.

Dr. J. J. Woodward, in a letter to Dr. L. Parks, quoted in the report of a Committee of the Massachusetts Medical Society, on Spotted Fever, or Cerebro-Spinal Meningitis, in the State of Massachusetts, May, 1866, says, with reference to this disease, as observed in the Federal armies during the civil war, 1861–1865, that

> "There were at least two classes of cases brought under the observation of this, the Medical Department of the army. In the first, the autopsy disclosed grave anatomical lesion of the cerebro-spinal axis, accumulations of serum, sero-pus, pus, or tough, yellow lymph, especially in the ventricles, about the base of the brain, and in the upper part of the spinal canal. In the second class of cases, no perceptible anatomical lesion in the cerebro-spinal axis was observable. These two groups of cases rest upon equally reliable evidence, and are not to be disposed of on the supposition that the latter represent merely an early stage of the former, since it is to be remarked that both anatomical conditions appear to have been found indifferently in protracted cases, as well as in those whish proved suddenly fatal."

After an extended investigation of the nature of Cerebro-Spinal Meningitis, prevailed in the Confederate army and after the performance of post-mortem tions, both during and subsequent to the war, in widely separated portions of Southern States, and after a careful examination and comparison of the American and European physicians, and of both Federal and Confederate cers, I have found no facts or observations to justify that portion of the Surgeon J. J. Woodward, which would imply that in a certain class of cases of Spinal Meningitis, however protracted, " no perceptible anatomical lesion in the spinal axis was observable."

Until such a careful record of these cases has been furnished, as will permit of ful study and comparison, the preceding statement cannot be accepted as a generalization as to the nature of this disease.

Dr. Meredith Clymer, in his chapter on Epidemic Cerebro-Spinal Meningitis, lished in the Third American Edition of " The Science and Practice of Medicine, William Aitken," pp. 492–505, holds a theory similar to that originally by Dr. Hale and others, and more recently advocated by Drs. Gerhard, Levick, ward and others.

As a result of his inquiries, Dr. Clymer is compelled to conclude that,

> "The pathogeny of epidemic Cerebro-Spinal Meningitis is still unsettled. There is to say that it is not a variety of simple or idiopathic inflammation of the membranes of brain and spinal-cord, nor of typhus fever, nor of pernicious paludal fever, but a disorder, consistent with itself in all material points, with constant symptoms, produced constant cause, and hence entitled to be described and regarded as a distinct disease proper nosological place is amongst general diseases, born of an external morbid poison; be owned that its pathogenic nature remains unknown."

Beyond the general statement of Dr. Woodward, Dr. Clymer adduces no facts tain his hypothesis as to the nature of Cerebro-Spinal Meningitis.

I have thus endeavored to present an unbiased account of the symptoms and logical lesions of Cerebro-Spinal Meningitis as observed by myself and other of the Confederate Army; and have carefully consolidated such a body of facts observations, recorded by competent observers during the last half century, enable me to draw conclusions as to the *nature of this disease*.

PRACTICAL CONCLUSIONS.

Cerebro-Spinal Meningitis should be classed with the Phlegmasiæ and not with Pyrexiæ.

The exciting causes, as far as known, the origin, progress and lesions and changes of this disease are similar to those of acute idiopathic Peritonitis, and Pneumonia and Acute Rheumatism.

In Cerebro-Spinal Meningitis, as well as in Acute Pleuritis, Peritonitis and monia, the first symptoms are sudden, sharp, and grave, and the inflamed and tissues, commence in a short time to pour out fibrinous inflammatory lymph, with living exudation, granules and corpuscles capable of higher development organization. The term "*head Pleurisy*," applied by the common people in some of the Southern States, to Cerebro-Spinal Meningitis, is by no means an term, as expressing the analogy which exists between this disease and Pleuritic mation.

Without doubt one of the most potent causes of the various forms of inflammations is exposure to cold and the consequent arrest or perversion of the of the skin.

Inflammation of the Kidneys, Lungs and Pleura, appear to be caused not by the degree of cold, as by sudden variations of temperature and moisture. known that Pneumonia often prevails as an epidemic over large tracts of varies in its type, and in the rate of mortality, and in the rapidity of its certain atmospheric and climatic changes.

erm *Epidemic*, may with equal force be applied to Pneumonia as it prevails at eriods in the sub-tropical and temperate zones of the earth.

flammations have been divided into two classes, viz; extrinsic and intrinsic; ner term being applicable to all those cases in which an injury, either sustained ffected part, or inflicted elsewhere, is the obvious cause of the morbid process; er to those inflammations which from the concealment of the cause have been diopathic. To the latter class must be referred Cerebro-Spinal Meningitis, Acute s, Peritonitis, Pneumonia and Nephritis and Rheumatism.

production of Idiopathic inflammations by climatic causes and especially by sud- iations of temperature and moisture, may be referred to two causes.

It may be supposed that an impression received by afferent nerves distributed ous or cutaneous surfaces is reflected to internal organs, causing primarily derange- f nervous and vascular action; and secondarily derangement of nutrition, secre- d excretion.

It may be supposed that sudden variations of temperature and moisture, may the suppression or diminution of certain important excretions as those of the d lungs, and induce the accumulation of certain noxious excrementitious matters blood, which may secondarily not only alter the normal and healthy constitution fluid, but also induce disturbances in the nervous supplies and circulation, and n of various organs. In this case the action of the external cause inducing the on, perversion or suppression of certain important functions, precedes the earliest local disorder, and it is through the medium of the blood, or by the blood-ves- t the offending materials act upon the nervous centres presiding over the circu- nd nutrition, and upon the internal organs. Inflammations thus induced have e, much in common, with the so-called *infective inflammations*, arising, as in the h puerperal peritonitis ("*puerperal fever*,") from the direct introduction into d of poisonous material.

erebro-Spinal Meningitis, the circulation of the pia-mater is at first accelerated creased, subsequently retarded and diminished, and the latter condition is d as in inflammation generally of any organ or tissue, by exudation of liquor is, and emigration of the white corpuscles (*leucocytes*,) from the blood through lls of the capillaries. The subsequent changes, in the inflamed membranes and s of the Cerebro-Spinal Nervous System, all indicate *increased activity of cell-*

local manifestations of inflammation in this disease are attended by a decided e of the fibrinous constituent of the blood, as in acute inflammations generally.

tendency of those fevers, which arise from blood poisoning, as Typhoid, Typhus, and Malarial fever, is to degeneration and disorganization of the blood, and of reting organs, and of the secretions and products peculiar to the disease.

s Malarial fever is characterized by a rapid destruction of the colored blood cor- , and by profound alterations in the liver and spleen, different entirely in character he morbid process denominated inflammation. The malarial liver with its slate with its altered bile, disintegrated blood corpuscles, flakes of altered hæmatin, th its chemical actions so altered, that cellulose increases, and grape sugar dis- , presents a very different condition from an inflamed liver.

inflamed structures of the diseased liver, tend either to destruction and removal, n alteration arising from the effusion and organization of plastic, inflammatory ; on the other hand some of the peculiar changes wrought by the malarial poison liver, may remain for months and even years. The enlarged, softened, disor- d spleen, resembling a bag of soft mud, in malarial fever, is far different from the ed, inflamed spleen.

deposit filling the glands of Peyer, and the Mesenteric Glands, in Typhoid fever, gh containing exudation corpuscles tends to degeneration and not to the forma- distinct fibrous tissue, as in Pleuritis, Peritonitis and Cerebro-Spinal Meningitis.

word, Cerebro-Spinal Meningitis, like other acute inflammatory diseases, is characterized by an increase of fibrin in the blood, and by the formation of deposits of inflammatory lymph, capable of organization into fibro-elastic tissue; whilst on the other hand, the true uncomplicated fevers, are characterized by a decrease of fibrin, and the tendency to passive hæmorrhages.

The very diversity of the symptoms in Cerebro-Spinal Meningitis, would indicate that the disease, is not due to any special poison, acting upon the blood, as in certain well known fevers. Upon the supposition of a special blood poison, we cannot account at all, for the fact that in some cases, the symptoms are so obscure and light that the nature of the disease is hardly suspected before death; whilst in others, the disease is announced with violent delirium and convulsions.

The diversity of the symptoms of meningitis has been well illustrated by the cases already presented, and especially by those recorded by Dr. P. Gervais Robinson, in the paper given in the preceding chapter. The cases of Cerebro-Spinal Meningitis reported by Dr. Robinson, occurred in the same Company. The phenomena of the first case were few, and very obscure, and not sufficient to lead to a just appreciation of their gravity—the patient complained on the first day, of a dull constant headache, which was persistent, and from which he could obtain no relief; pulse not perceptibly abnormal in rapidity, calibre or force; the tongue presented no departure from a state of health, and the only other symptom, besides the headache, which indicated disease, was a constipated condition of the bowels. After the first twenty-four hours, there was perhaps some disposition to drowsiness, from which however, the patient was easily aroused; there was at no time, however, delirium, and no variation in the size of the pupil; and up to the third morning there was so little apparent cause of disease, that Surgeon Robinson was inclined to regard the complaint of the patient with suspicion as to his honesty. On the morning of the fifth day, he became profoundly comatose, and died the same day. An autopsy, a few hours after death, revealed an extensive effusion of coagulated lymph between the arachnoid and pia-mater of the brain and spinal cord; the deposits or exudations of lymph were found in greatest quantity about the base of the brain, and around the medulla oblongata and commencement of the cord.

On the same day that this soldier died, his brother complained of a dull and persistent headache, and in the evening became violent and suddenly delirious, and raved and struggled to such a degree, as to require the aid of three or four men to restrain him. The pulse was about ninety beats to the minute, full and strong, and the bowels closely constipated. By the use of cold water poured over the head in considerable quantity, the more violent paroxysms were controlled; and by the steady application of wet cloths, in eighteen hours his delirium subsided, and reason was restored. The bowels were moved with Croton Oil; and blisters applied to the nape of the neck and spine, constituted the list of remedies used in this stage of the disease. From this time, until about the end of the fifth day, the disease appeared to be quiet and inactive, the patient being tranquil and quite rational, and partaking of such light nourishment as could be procured in camp. During this period of intermission, there were no very remarkable symptoms of disease, the pulse being almost quite normal, the tongue and skin presenting no very peculiar or characteristic conditions, and perhaps the only appreciable sign of any lesion of the brain was exhibited in the paralysis of the sensory root of the fifth pair of nerves, thus destroying the sensibility of the face. Towards the end of the fifth day, the functions of the optic began to be interfered with, and vision became impaired, together with dilatation of the pupils Dr. Robinson, also observed, that during this interval, the sensibility of the *portio mollis*, was much increased, the hearing unusually acute, and the patient's attention would be attracted by the slightest noise, and he would even remark upon what was said in a low tone, at some distance from the bed. A part of this time, he could not recognize a watch held at his nose, nor feel a severe pinch of his cheek. From this he became much prostrated, and sank into a state of collapse, and soon profound coma supervening; in this condition he continued until about the seventh day of disease, when death, apparently dependent upon paralysis of the respiratory nerves, closed the scene.

The third case followed close upon the second, and was ushered in with the like symptoms; the patient first complaining of severe headache, succeeded by violent and maniacal delirium, requiring physical force to restrain his muscular efforts. The course of this case was very similar to that of the preceding, with the exception of a variation in the paralytic phenomena. In this case, the *portio mollis* was affected intensely, and the patient was quite deaf after the third day. The delirium subsided as readily, and there was the same defective intermission in the march of the disease. In this case, however, this intermittent stage was more protracted, and that of collapse followed by coma, came on about the sixth, and death about the ninth day of the disease. Post-mortem examinations of the second and third cases, presented the same general appearances as the first, except that in these, the lymph exudations were more extensive, and there was much greater injection of the vessels of the membranes. In these two, the lateral ventricles were filled to their greatest capacity, with fluid. The structures of the Brain, in neither case presented any appearance of inflammation. The accumulation of thick yellow lymph, was greatest at the base of the brain, the commissure of the optic nerves, medulla oblongata, and commencement of the cord.

The hypothesis of a special poison acting through the blood upon the ganglionic cells of the nervous system, will not explain in any satisfactory manner the preceding phenomena, with their sudden and marked diversities and variations; when we refer, however, to the local manifestations and the pouring out of organizable lymph around the delicate central nervous ganglia inclosed within a firm unyielding bony case, the characters and diversity of these manifestations of nervous and muscular disturbances, are readily comprehended.

2. The Temperature in Cerebro-Spinal Meningitis, varies in accordance with the extent and character of the local inflammation and the secondary results of the primary diseased condition, and does not manifest regular and defined changes as in the essential fevers; it is evident, therefore, that the phenomena of Cerebro-Spinal Meningitis, are not to be referred to a definite poison, acting primarily upon the blood.

It is now well established that the thermometric phenomena of Yellow Fever, Intermittent Fever, Small-Pox, Measles, Scarlatina, and Typhus and Typhoid Fevers, present definite and characteristic changes, which may be represented by distinct curves.

In idiophatic inflammations, however, the temperature will vary as in the essential fevers with the severity of the disease, but also with the stage of the inflammation, and with the subsidence, or fresh accession of inflammatory action.

The fever accompanying acute inflammations, should be regarded as *one of the results* of the inflammatory action, and not as *the cause*.

The fever of Cerebro-Spinal Meningitis, is the result or necessary companion of the local inflammation in the Cerebro-Spinal Nervous System, and is not the *cause* of the local inflammation.

I have observed many cases in which *fever*, viz: increased animal temperature, increased circulation and respiration, and increased chemical change, directly resulted from *local inflammation*.

The following case which I select from a large number, of a similar nature, observed by myself, will illustrate the truth of the preceding proposition in a clear manner:

Case 585: Frost Bite, Gangrene of Both Feet; Amputation of both feet, recovery; the local injury and inflammation, attended with great elevations and continual fluctuations of temperature.

Joaquin Gonzalles, age 42; native of Portugal; entered Ward 13, Charity Hospital, Nov. 21st, 1873, with Frost Bite of Both Feet. Patient says, "that on the night of the 17th of November, he was out hunting in the swamp, and that his feet were immersed in the cold mud for several hours. The night was unusually cold for this latitude, (Louisiana), and the surface of the ground was frozen. On the next day the feet were red and painful."

At the time of his entrance, four days after exposure to the cold mud (Nov. 21st), both feet presented a deep purplish hue, and the toes felt cold to the touch.

The following table presents the record of the Pulse and Temperature:

DATE.	TEMPA.		PULSE.		REMARKS.
	M.	E.	M.	E.	
1872.					
Nov. 22	101.5	103.	120	108	Half of both feet including toes
" 23	100.6	102.5	102	108	blue and inclining to black.
" 24	101.2	103.	108	.....	
" 25	100.5	102.5	.....	.....	
" 26	102.	103.5	120	126	[and insomnia.
" 27	101.4	102.	120	112	Complains of great pain in feet
" 28	100.6	103.	110	116	Feet gradually turning black,
" 29	103.	103.5	126	128	especially about the toes. The
" 30	101.	102.5	116	112	toes are becoming dry and
					shrivelled.
Dec. 1	102.	104.	112	112	Patient complains of constant
" 2	101.	104.8	112	120	tingling and pain in the feet.
" 3	102.3	102.	130	132	Sweats profusely; unable to
" 4	102.5	105.8	120	132	sleep.
" 5	104-8	100.5	136	102	Feet emit a foul odor and have
" 6	102.	105.5	112	114	been dressed with carbolic
					ointment since Nov. 25th.
" 7	105.5	105.	120	.....	Distinct line of demarcation
" 8	102.8	105.	120	126	forming about middle of both
" 9	103.2	103.5	126	108	feet on the 16th day of injury.
" 10	102.5	105.	114		Considerable discharge from
" 20	100.	101.5			feet. Pulse very feeble. Pa-
" 21	101.	101.5			tient shivers and complains
" 22	101.8	102.			of cold. Patient very weak.
" 23	101.8	102.			
" 24	101.8	102.			
" 25	101.5	102.			
" 29	99.5	101.5			
" 30	99.5	101.8			
" 31	100.7	101.			
1873.					
Jan. 1	99.				
" 2	100.4				
" 3	99.				
" 4	99.8				
" 6	99.				
1873.					
Jan. 7	100.2	......			
" 9	101.	......			
" 10	100.	......			
" 11	101.2	98.3			Right foot amputated Jan. 11.
" 12	101.2	......			
" 13	102.	......			
" 14	101.5	......			
" 16	99.	......			
" 18	100.	......			Had a chill at 12 M. on the
" 19	100.	......			18th, followed by fever.
" 25	99.2	......			Had another chill on the
" 29	99.	99.2			12th.
" 30	99.	99.4			
" 31	101.5	101.			
Feb. 1	100.	101.			
" 2	101.4	101.			
" 3	101.	101.4			
" 4	101.4	101.8			
" 5	101.2	101.4			
" 6	101.	101.2			
" 7	101.	101.5			
" 8	100.	90.			
" 9	101.	101.5			Left leg amputated. Before
" 10	101.5	101.			amputation, Tempera'e 100.
" 11	100.	100.5			Under the influence of
" 12	101.	101.5			Chloroform, the tempera-
" 13	102.	101.4			ture fell in ¾ of an hour to
" 14	102.2	101.			90°. In the evening of
" 15	100.	104.			same day the temperature
" 16	104.	104.			was 101°.
" 17	111.	104.			
" 18	101.5	104.			
Mar. 3	......	105.5			Pus borrowing under texture
" 4	103.	105.			and causing pain and
" 5	104.				sloughing.
" 6	101.				

When this patient entered my ward, he was in such an exhausted and feeble state, with rapid and feeble pulse, that it appeared almost impossible that his system could possess sufficient strength to cast off the dead tissues. The treatment consisted of Quinine, Tincture of the Sesquichloride of Iron, nutritious diet, (beef steak, beef tea, soft boiled eggs, milk and bread,) with liberal supplies of Brandy and Port Wine. The feet were dressed twice each day, with soft English Lint, coated with Carbolic Acid Ointment, of the strength of one drachm of the saturated solution in Alcohol to the ounce of Simple Cerate. Notwithstanding the excessive suffering, profuse sweats, and the exhausting fever, induced by the absorption of the gangrenous matters into the blood, and the local inflammation around the dead tissues, the patient not only maintained his strength but slowly improved under the treatment instituted.

As soon as the line of demarcation had been established between the dead and living tissues of the right foot, and the strength of the patient appeared to be sufficient to withstand the shock, the right foot was amputated at my request by Professor Logan, on the 11th of January. The shock of the amputation was very great and the temperature sank down to a low figure, and the patient did not fully rally until after the lapse of several days. The left foot was amputated on the 8th of February; before the operation the temperature of the axilla was 100° F.; three quarters of an hour after the amputation, the temperature was only 90° F.; this reduction I attributed chiefly to the effect of the Chloroform. In the evening of the same day the temperature had risen to 101° F., which was about his average temperature, except when suffering with marked increase of the hectic fever. On the 13th, the temperature in the evening was 104°, and this elevated temperature continued until February 22d, with slight daily oscillations. This rise was due to the formation of an abscess in the tissues near the ankle joint. After opening and evacuating the abscess, the temperature fell from 104° to 100°. There was another marked rise of temperature on the 3d of March, the thermometer in the axilla indicating 105°.5 F.; caused by the formation of another abscess.

In this case, during a period of one hundred and ten days, the temperature ranged from 99° to 105°.5 F.; the diurnal oscillations being always greater than in health, and the marked elevations of temperature being connected with the nature and extent of the local inflammation during the separation of the gangrenous feet, and during the healing of the stumps and the subsequent formation of abscesses in the legs, near and around the seats of the amputations. I have carefully preserved the feet of this patient in the dry state, by means of certain chemical and organic substances, and it will be seen upon inspection of the specimens, which have not been altered in size, color or appearance to any very marked extent, that the separation of the gangrenous parts by the natural processes had been almost complete before the performance of amputation. The elevated temperature (with its marked diurnal oscillations), was attended by a rapid pulse, rapid respiration and profuse sweats at night; sleeplessness and intense thirst and great nervous prostration. The recovery of this patient was satisfactory and complete, and at the time that the stumps had completely healed, he presented the appearance of good health, and he was much heavier than when the feet were first frozen. Without the liberal use of Alcoholic Stimulants, Nutritious Diet, Quinine and Iron, it is believed that the case would have terminated fatally.

This case thus sustains the proposition, that the *fever* which accompanies acute inflammation should be regarded as one of the *results* of the inflammatory action and not as the cause.

3rd. In Cerebro-Spinal Meningitis the pia-mater appears to be chiefly affected, but the arachnoid and dura-mater may also be involved in the inflammatory action; whilst on the other hand the nervous structures of the brain and spinal cord, appear as a general rule to be free from inflammatory action. This absence of inflammatory action from the brain and spinal marrow, affords an explanation of the fact, that the intellect frequently continues to manifest its powers, undisturbed, for considerable periods of time, and in some cases during the whole course of the disease, even when post-mortem examination indicates the presence of profound lesions in the investing membranes.

If the nervous elements of the brain and spinal cord and cervical nerves (ganglionic cells, commissures, nerve tubes and nervous connective tissue,) are primarily involved in Cerebro-Spinal Meningitis, it would be impossible to explain the suddenness and violence of the symptoms, and the rapid fatal results in the absence of all lesions recognizable by microscopic investigation. If on the other hand, it be true, that an effusion of coagulable lymph is just as capable of producing pressure and deranged action in the brain and spinal cord, as an effusion or hæmorrhage of blood within the bony case of the Cerebro-Spinal Cavity, it can be readily conceived that the inflammation of the nutritive membrane, and the coating of the most delicate and important nervous structures, confined in a bony case, with a dense exudation, tending to organize itself progressively into more firm and resisting structure, might give rise to all the phenomena of Cerebro-Spinal Meningitis.

4th. The derangements of the circulation and respiration, and of the secretions and excretions as well as of the nervous functions in Cerebro-Spinal Meningitis, may all be referred to the local inflammation of the meninges of the brain and spinal cord.

The theory, that the febrile phenomena, the derangements of circulation and respiration, and the mottling and discoloration of the surface, are due to the action of a distinct blood poison, is not necessary for the explanation of the phenomena, and is not sustained by the natural history of the disease. Derangement in the action of the medulla oblongata and of the nerves, given off from the base of the brain caused by the meningeal inflammation, and by the pressure of the products of inflammatory action is entirely sufficient to account for the derangements of circulation and respiration, and for the stagnation of the blood in the capillaries of the surface, and the consequent mottling of the surface, as in Malignant Malarial fever. Not only is the fibrin increased in the blood in Cerebro-Spinal Meningitis, but marks of disorganized blood and of bloody effusions, are absent as a general rule from the structures most inflamed and diseased, viz: the meninges of the brain and spinal cord, and in those cases in which circumscribed discoloration of the membranes of the brain and of the pleura and pericardium have been observed after death, such appearances were evidently caused by local congestions and *post-mortem* exudations of the coloring matters of the blood. And even if it should be true, that the blood is disorganized in certain cases of Cerebro-Spinal Meningitis, such disorganization may be entirely explained by the derangements of the circulation and respiration induced by the disturbance and perversion of the functions of the Cerebro-Spinal System. All the facts, however, point only to a want of proper oxygenation of the blood, and to a tendency to stagnation of the venous blood in the capillaries of the periphery. Petechial spots are absent in the majority of the cases, and in many epidemics not more than 17 per cent. of the cases manifest any mottling or petechial spots of the surface. In soldiers and in the poorer classes, whose diet has consisted largely of salt food, the presence of petechial spots during the progress of this severe disease, is largely due to the preceding scorbutic condition of the blood.

5th. An explanation of the almost universally fatal character of Cerebro-Spinal Meningitis, as well as the tedious nature of recoveries from the disease, may be found in the physiological actions of the nervous structures involved, and in the nature and effects of the products of the inflammatory action. The prognosis of every well defined case of this disease, must be doubtful and unfavorable. Even after the subsidence of all active inflammation in the meninges of the brain and spinal cord, the most serious consequences may follow, and all the dangerous symptoms and derangements of the most essential functions of life may be kept up by the mere mechanical action of the organizable and organizing fibrous effusion. The period of convalescence from this disease will depend, not only upon the amount of fibrous inflammatory effusion, but also upon the character and rapidity of the subsequent changes, resulting in the formation of fibrous tissue, and in the gradual absorption of some portion of the products of the diseased action.

6th. The treatment of Cerebro-Spinal Meningitis, based upon the preceding principles, should be, in the first stages of the disease, entirely directed to the arrest or modification of the acute inflammatory action.

As soon as the practitioner has convinced himself that the disease is Cerebro-Spinal Meningitis, and not Pernicious Malarial Fever, the patient should be freely bled, (in the upright posture if possible), the blood being allowed to flow in a full stream until the patient feels faint and exhausted; from ten to forty ounces of blood should be taken, the amount being regulated by the severity of the case, and the age, constitution and strength of the individual.

Cut-cups should be freely applied to the temples, to the back of the head and neck, and along the entire region of the spine, and from four to eight ounces of blood be thus withdrawn over the region of the brain and spinal cord.

The bowels should be freely opened with Calomel, and, if necessary, with Croton Oil.

The back of the neck and head should next be shaved, and a blister applied over the region of the cerebellum and back of the neck, and down the entire length of the spine. Over the spine, this blister should not be wider than from one inch to one and a half inches.

After the free evacuation of the bowels, Mercury should be given in small doses, combined with Opium, with a view to mercurialization. The Mercury may be advantageously combined with Dover's Powder and Quinine, as in the following formula: ℞. Hydrargyri Subchloridi (Calomel), ʒ ss; Pulv. Doveri (Pulv. Ipecac et Opii), ʒ ii; Quiniæ Sulph, ʒ i; mix; divide into 30 powders; Sig: One powder every two or three hours.

When it is evident that active inflammatory symptoms have subsided, the strength should be supported by nutritious diet, and alcoholic stimulants judiciously administered in small quantities, at regular intervals. The pain, and restlessness, and the sleeplessness, and delirium, and the contractions of the muscles of the neck and back, should be treated by Chloroform administered *internally*, in conjunction with Opium and its preparations, by Hydrate of Chloral, Croton, Chloral Hydrate, and by Cannabis Indica, Aconite, and Calabar Bean and Bromide of Potassium.

Counter irritation should be kept up along the back of the neck and spine, by blisters, or by Croton Oil.

After the subsidence of the acute inflammatory symptoms, the convalescence will be, in all cases where there has been an extensive effusion of fibrinous lymph, tedious during the transformation of portions of the deposit into fibrous tissue, and the gradual absorption of others. During these slow changes, the strength must be supported; and active depletory measures employed with caution, as they may retard the reparative process.

In instituting this vigorous plan of treatment, the physician should be confident of the correctness of his diagnosis, for such treatment in Pernicious Malarial Fever, might be attended with serious results. When the disease is complicated with Malarial Fever, Quinine should be administered freely, and caution should be exercised in the abstraction of blood.

CHAPTER VIII.

OBSERVATIONS ON THE RELATIONS OF CEREBRO-SPINAL MENINGITIS TO MALARIAL FEVER. CASES OF CEREBRO-SPINAL MENINGITIS, WHICH OCCURRED AT SAVANNAH, GEORGIA, FEBRUARY AND MARCH, 1863.

EFFECTS OF DERANGEMENTS OF THE BLOOD, ARISING FROM DEFECTIVE CIRCULATION AND RESPIRATION, UPON THE ORGANS AND TISSUES. THE DERANGEMENTS OF THE CIRCULATION AND RESPIRATION, AND OF THE SECRETIONS AND EXCRETIONS, AS WELL AS OF THE NERVOUS FUNCTIONS IN CEREBRO-SPINAL MENINGITIS, MAY ALL BE REFERRED TO THE LOCAL INFLAMMATION, CONGESTION, AND ALTERATION OF THE MENINGES (ESPECIALLY THE PIA-MATER) AND STRUCTURES OF THE BRAIN AND SPINAL CORD. CEREBRO-SPINAL MENINGITIS RESEMBLES IN ITS ORIGIN AND PROGRESS, INFLAMMATORY DISEASES, AND HAS FREQUENTLY PREVAILED AT THE SAME TIME, AND BEEN INTIMATELY ASSOCIATED WITH INFLUENZA, CATARRH, AND PNEUMONIA. THE CHANGES OF TEMPERATURE DURING THE PROGRESS OF CEREBRO-SPINAL MENINGITIS, INDICATE THE ACTION OF THE AGENT PRODUCING THE DISEASE, DIRECTLY ON THE CEREBRO-SPINAL SYSTEM, RATHER THAN ON THE BLOOD. THE CONDITION OF MANY PATIENTS DURING CONVALESCENCE FROM CEREBRO-SPINAL MENINGITIS, INDICATES IN THE CLEAREST MANNER, THAT THE CEREBRO-SPINAL NERVOUS SYSTEM, HAS BEEN INFLAMED AND PARTS OF THE STRUCTURES PERMANENTLY ALTERED, RATHER THAN THAT THERE HAD BEEN NOTHING MORE THAN THE ACTION OF A SPECIFIC FEVER POISON UPON THE BLOOD. EXPERIMENTS ILLUSTRATING THE ACTION OF VARIOUS POISONS UPON LIVING ANIMALS AND DESIGNED TO ILLUSTRATE THE PRECEDING PROPOSITIONS.

My attention was strongly directed to the important question of the relations of Cerebro-Spinal Meningitis to Malarial fever, by the examination of several cases of a fatal form of disease, which occurred in the months of February and March, 1863, amongst the Confederate troops assembled for the defence of Savannah, Georgia.

During the prosecution of investigations upon camp diseases, amongst the Confederate Troops, stationed along the coast of Georgia, my friend and colleague Dr. H. V. M. Miller, Chief Surgeon of the District of Georgia, requested me to examine some sudden and severe cases of disease, which had occurred in the 32d Regiment of Georgia Volunteers, at that time camped near the southern boundary of Savannah, at Camp William Duncan Smith.

According to the testimony of Surgeon Hugh A. Blair, of the 32d Regiment, almost the entire command, of an average mean strength of one thousand men, had suffered with Malarial fever, and many of the men whom I saw upon regimental parade, showed in their sallow anæmic faces, the effects of malaria.

In the hospital of this regiment, which was crowded with cases of Typhoid fever, pneumonia, and malarial fever, I observed three cases, suffering with a form of disease which had been sudden in its inception, violent in its symptoms, and resembling in its main features, Cerebro-Spinal Meningitis.

In the latter part of February, a few days before my visit, five of these cases had occurred and two proved fatal. Three of the five cases, commenced with strong convulsions, followed in a short time by delirium. In four of the cases, the pupils were dilated; and the conjunctiva was congested in all. In one case the pupil was alternately dilated and contracted. Pulse weak, but not specially accelerated. Respiration apparently natural at the commencement of the disease, but gradually became stertorous and irregular. Coma rapidly supervened, and the patients died in from 12 to 18 hours.

The three cases which I examined, presented an anæmic and sallow hue, as if the patients had been subjected to the prolonged action of malaria; and upon inquiry I found that they had in each case suffered previously with chill and fever. These cases presented somewhat the symptoms of severe concussion of the brain; the patients lay with the eyes open, without moving or noticing anything passing around them, and when the attempt was made to arouse them they gave little or no sign of intelligence. These cases terminated fatally in the course of a few days. It might with some reason, be supposed that the continued action of malaria, had produced changes in the constitution of the blood and of the cerebro-spinal structures, and that at length during the congestive stage of the disease, accompanied also by the action of cold, irritation of the meninges of the brain and spinal cord was excited, and serous effusions took place into the ventricles of the brain, and around the brain and spinal cord.

Similar cases occurred about the same time, in the General Hospital in Augusta, Georgia; six cases,—the entire number proved fatal. All these were soldiers who had been suffering with malarial fever in Savannah, and had been transferred in the latter part of the fall to Augusta. In each one of these six cases, the malarial fever had not been arrested, and the patients exhibited its effects in their pale, sallow, and anæmic hue.

In most of the cases occurring in the General Hospital of Augusta, the disease was ushered in with an intense pain in one of the eyes, which was speedily followed by coma and death, in from 18 to 50 hours.

Surgeon Blair, informed me that a case similar in some respects to those previously described, occurred as early as September, 1862. The patient had had chills and fever for some time, and looked sallow and anæmic. Had missed his chills for several days, and had taken no Quinine for two days. On the 10th of September, 15 grains of Quinine in three doses were administered early in the morning, the last dose having been taken at 8 o'clock, A. M. The Quinine had been given with a view to prevent the recurrence of the chill as the patient appeared to be in his usual health. At 1 o'clock P. M., whilst attempting to put on his shoes, the patient suddenly fell, became insensible and never rallied. In two hours he was jaundiced—even his tears were yellow, the pupils were largely dilated, pulse not specially accelerated, but weak. The patient died at midnight of the same day upon which he was seized.

RELATIONS OF CEREBRO-SPINAL MENINGITIS AND MALARIAL FEVER.

The following tables which I have consolidated from my labors and investigations concerning Malarial Fever, commenced in 1856, will furnish data for careful comparison with the symptoms and pathological anatomy of Cerebro-Spinal Meningitis, as described in the preceding chapter.

TABULAR VIEW OF THE CHANGES OF THE BLOOD AND URINE AND CIRCULATION, RESPIRATION AND TEMPERATURE IN MALARIAL FEVER, DEDUCED FROM THE STUDY OF MORE THAN TWO THOUSAND CASES, DURING A PERIOD OF TWENTY YEARS—1856 TO 1875 INCLUSIVE, BY JOSEPH JONES, M. D.

CHANGES OF THE BLOOD IN MALARIAL FEVER.

The malarial poison is capable of altering the constitution of the solids and fluids, and of modifying and altering the type, and progress, and effects of various diseases, even when no symptoms of aberrated physical, chemical and nervous actions have been manifested, sufficient to arrest the attention of the patient.

The *colored blood corpuscles* are diminished during Malarial Fever; the extent and rapidity of the diminution of the colored corpuscles correspond to the severity and extent of the disease. The fixed saline constituents of the colored blood corpuscles, are often diminished in Malarial Fever. The colored blood corpuscles are destroyed both in the liver and spleen. The colored blood corpuscles are more uniformly and rapidly destroyed in severe cases of Malarial Fever, than in any other acute disease, with the exception, perhaps, of Pyæmia.

The *specific gravity* of both the blood and serum is diminished during the active stages of Malarial Fever, and during the slow action of the malarial poison.

The *solid matters* of the blood are more rapidly and decidedly diminished in Malarial Fever than in any other disease. The color of the blood and serum is altered; in severe cases, the blood, when first abstracted, presents a dark purple, almost black color, and changes slowly to the arterial hue when exposed to the atmosphere; and in severe cases it changes to a cherry red color, and not to the bright red assumed by the surface of healthy, venous blood. The blood of the liver and spleen, after death from Malarial Fever, presents a deep purple, and almost black color, and does not change to the arterial hue upon exposure to the atmosphere. Serum golden colored in severe cases. The clot forms more slowly, and is more voluminous than in normal blood.

The *fibrin* is diminished greatly in severe cases of Malarial Fever; the diminution of this element of the blood is characteristic, not only of Malarial Fever, but of all fevers; whilst its increase, on the other hand, is characteristic of the phlegmasiæ. As a general rule, the diminution of the fibrin in Malarial Fever, as in the pyrexiæ, generally corresponds with the severity of the disease, provided there be no inflammatory complication. The diminution and alteration of the physical properties of the fibrin in Malarial Fever, to any great extent, was always accompanied by congestion of the spleen, liver and brain, and serious cerebral disturbances. The fibrin is not only diminished in malarial fever, but it is altered in its properties, and in its relations to the other elements of the blood, and to the blood-vessels; and in severe cases, heart clots (fibrinous concretions), are frequently formed before death.

The albumen is diminished during the active stages, but such diminution is not due to any loss of this element in the urine. As a general rule, albumen is absent from the urine in Malarial Fever, and when present, as in Malarial Hæmaturia, it is accompanied with blood corpuscles, and with casts of the tubuli uriniferi containing colored blood corpuscles.

CHANGES OF THE CIRCULATION, RESPIRATION AND TEMPERATURE.

Intermittent Fever.—During the cold stage, (chill), there is a rapid, feeble pulse, rapid respiration, and hot trunk, and cold extremities—the temperature of the extremities is reduced far below that of the trunk, and even below the standard of health, because the circulation of the blood in the peripheral capillaries is to a great extent arrested, apparently by the contraction of the unstriped muscular tissue of the walls of the minute arterioles. The diminution of the capillary circulation, and the reduction of the temperature of the extremities, precede the aberrated nervous and muscular phenomena denominated chill. This fact corresponds with the changes in the constituents of the blood, and indicates that the first phenomena of the cold stage are connected with derangements of the vaso-motor system of nerves. As a general rule, the higher the temperature of the trunk during the cold stage, the more rapid will be the equalization of the circulation and temperature. The severity of the fever (animal temperature), which often reaches, in the hot stage, 107° F., is by no means an index of the character and severity of the subsequent effects. As a general rule, the higher the temperature (within, of course, certain defined limits, not exceeding 102° and 107°.5 F.), the more readily does the attack yield to treatment. The changes of the temperature in Intermittent Fever, are characterized by abrupt elevations and depressions, so that when the curves are projected upon a chart, they differ in the rapidity of the elevations and depressions from those furnished by all other diseases.

Remittent Fever.—The phenomena of the cold stage preceding the hot stage of Remittent Fever, are similar to those of Intermittent Fever; the difference is one of degree, and not of kind; the phenomena of the cold stage of Remittent Fever are more protracted than those of Intermittent Fever; the sympathetic system does not so rapidly regain its normal action, and the circulation in the capillaries of the extremities is not so rapidly restored in Remittent as in Intermittent Fever. The alterations of the blood are more profound in Remittent than in Intermittent Fever, and therefore it results that the cold stage is more prolonged in Remittent than in Intermittent Fever. The elevation of temperature corresponds more accurately, with the increased actions of the circulatory and respiratory systems in Intermittent than Remittent Fever. Remittent Fever may be distinguished from Typhoid Fever by the greater and more sudden elevations and depressions of temperature.

Congestive or Pernicious Fever.—The complete prostration of the muscular and nervous forces the reduction of animal temperature, both in the trunk and extremities, the cold, clammy sweat, the rapid, feeble pulse, the rapid, thumping action of the heart, and the sudden intervention of the most alarming cerebral symptoms, may occur gradually or suddenly, in either Intermittent or Remittent Fever, and may be induced by several distinct causes acting singly or in conjunction. There is a want of coördination between the circulation, respiration and animal temperature in Congestive Fever. The respirations are full, accelerated, and often panting and heaving, varying from 30 to 50 per minute; the pulse beats from 120 to 160, and feels like a delicate thread, and is often so small that it cannot be counted; the heart thumps irregularly and spasmodically, and rapidly against the walls of the chest, as in some cases of narcotic poisoning; the circulation in the capillaries is feeble; the temperature of the trunk, notwithstanding the full, rapid respiration, sinks below the normal standard, and the surface is covered with cold, clammy sweat.

CHANGES OF THE URINE IN MALARIAL FEVER.

Intermittent Fever.—The *amount* of urine excreted during the active stages, and during the earliest stage of the intermission, is less than that of health, and this diminution relates to the water, and not to the solid constituents. During convalescence, and especially under the action of depurants, the amount of urine is increased. The color of the urine varies from light orange to deep red. During the active stages the free acid is increased, but diminishes during convalescence. The urea is increased, during the active stages, above the standard of health, and especially during similar conditions of rest and starvation. The uric acid is diminished, both with and without the action of Sulphate of Quinia, during the active stages, when the pulse is full and rapid, and the respiration full and accelerated, and the temperature elevated. As a general rule, when the fever declines, the uric acid increases above the standard of health, both with and without the action of the Sulphate of Quinia. In some cases the uric acid increased to four-fold the normal amount during convalesence. The urine of the intermission of Malarial Fever, is characterized by heavy yellow deposits of Urate of Soda and Triple Phosphates, the former in the form of granular and acicular masses, and the latter as beautiful prysmatic crystals. Phosphoric Acid is greatly diminished, and may even entirely disappear during the chill and first stage of the febrile excitement. The phosphates are more abundant in the stage of convalescence than during the active stages. The deposits (so-called critical discharges), so common during convalescence, consist chiefly of the Urates of Soda, Ammonia, and the phosphates, most generally in the form of triple phosphates. The Chloride of Sodium is abundant during the cold and hot stages. The Sulphuric, as well as the Phosphoric Acid, is increased during the height and decline of the hot stage. The urine excreted during the fever is generally deficient in Uric Acid and the earthy salts, whilst its acidity and power of resisting decomposition is greatly increased, and it will remain for a great time without undergoing decomposition. On the other hand, during convalescence, the urine rapidly undergoes change, and the deposits of the Urates of Soda and Ammonia, and the precipitation of the triple phosphates, by the Ammonia generated during the decomposition of the urea form the so-called critical discharges of Malarial Fever. Albumen is almost universally absent from the urine of uncomplicated Malarial Fever; it is present, however, in that form called malarial hæmaturia, characterized by intense jaundice, and congestion of the kidneys, and passive hæmorrhages. In such cases the urine contains blood corpuscles and casts of the tubuli-uriniferi filled with colored corpuscles.

The changes of the urine in *Remittent Fever*, are the same in kind, but different in degree, from those of Intermittent Fever. The urine is higher colored, more concentrated, and richer in urea, Phosphoric Acid and Sulphuric Acid. If the case be protracted, the Chloride of Sodium diminishes, as in Typhoid Fever. When the temperature falls below the normal standard in the early stage of convalescence, the urea, as in the similar stage of Intermittent Fever, decreases in amount. During the period of remission and convalescence, the Uric Acid, which had suffered decrease in the active stages, increases above the normal standard. The formation of deposits of the Urates of Soda, and of Ammonia, and of the triple phosphates, (critical discharges), in the urine of Remittent Fever, is similar in all respects, takes place at analogous periods, and is due to the same causes as in the urine of Intermittent Fever.

CASES ILLUSTRATING THE COMPOSITION OF THE URINE IN MALARIAL FEVER.

No. of Case.	Date, Year and Month.	Disease and Stage of Disease.	Hour of Day.	Pulse.	Respiration.	Temperature of Hand.	Temperature of Axilla.	PHYSICAL AND CHEMICAL CONSTITUTION OF URINE.									
								Length of period in which Urine was collected.	Amount of Urine collected—Grs.	Color of Urine	Specific Gravity of Urine.	Urea—Grains.	Uric Acid. Grains.	Free Acid. Grains.	Phosphoric Acid.—Grs.	Sulphuric Acid.—Grs.	Chloride of Sodium. Grains.
	1863.					Fah.	Fah.	Hours									
586	October 13...	Intermittent Fever, (Fever)..................	....	...	...	....	....	24	9,567	Orange..	1017.	240.	......	4.5	21.	9.2	92.
	...	" Intermission..................	12 M	64	22	96°.8	100°.4	24	7,140	Orange..	1017.	186.	......	12.1	21.	10.3	63.
587	October 13...	Intermittent Fever,															
	...	Two hours Cold Stage....................	3 P M	...	...	....	....	2	1,591	Orange..	1020.	53.9	......	2.1	0.3	......	18.4
	...	Three hours Hot Stage....................	6 P M	...	...	....	....	3	2,240	Orange..	1018.	58.1	......	3.8	0.2	......	30.1
	...	Fifteen hrs. Hot and Sweat'g Stage	A M	...	...	....	....	15	11,222	Orange..	1011.	189.	......	20.7	1.7	19.6	21.8
588	October 11...	Intermittent Fever, Hot Stage	11 A M	...	...	....	....	24	15,498	Orange..	1013.	241.	......	18.8	14.4	15.	135.
	...	Intermittent Fever, Intermission.........	11 A M	60	21	97.9	99.2	24	21,153	Orange..	1011.	309.	......	15.1	18.9	18.5	145.
	...	Intermittent Fever, Intermission.........	2 P M	...	...	....	....	24	18,270	Orange..	1015.	265.	......	......	20.3	26.	265.
589	October	Quotidian.....	1 P M	58	20	85°.8	99.7	24	51,115	Yellow..	1004.	307.	......	20.5	10.2	15.3	123.
590	October	Remittent Fever, Convalescence...........	11 A M	...	...	....	....	24	12,731	Red......	1018.	394.	......	24.66	36.9	19.7	6.1
	...	Remittent Fever, Convalescence...........	2 P M	68	20	95.6	101.3	24	12,090	Red......	1016.	327.	......	29.26	36.	18.	
591	October	Remittent Fever,															11.7
	...	Remission............................	3 P M	102	22	100°.4	100.8	24	9,180	Brown...	1020.	267.	......	44.6	31.4	15.1	19.6
592	October	Remittent Fever, Remission.................	2 P M	78	14	94.3	102.2	24	18,174	Orange..	1014.	445.	......	29.6	29.	21.3	110.6
	...	Remittent Fever, Remission.................	2 P M	...	...	....	....	24	18,216	Orange..	1012.	309.	......	24.7	22.	16.	113.
	...	Remittent Fever, Remission.................	2 P M	...	...	....	....	24	24,408	Orange..	1017.	414.	......	19.1	......	......	403.
	1862.	Intermittent Fever, (Chill)..................	12 M	124	...	88°.	107°.	2½	5,425	Yellow..	1016.	118.	1.0	7.3	0.6	3.5	76.9
593	July 27...	Intermittent Fever, (Fever)..................	5 P M	...	...	....	....	5	7,297	Yellow..	1008	99.4	0,65	6.3	0.5	5.0	53.0
	27...	Intermittent Fever, (Fever)..................	5 A M	...	...	....	....	12	15,193	Yellow..	1005.	163.	1.4	3.9	trace.	17.	40.
	28...	Intermittent Fever, (Fever)..................	10 A M	...	...	....	....	5	4,076	Orange..	1019.	138.	2.0	5.7	5.7	6.2	33.
	...	Chill and Fever....................................	....	...	...	....	....	24½	31,991	Orange..	1019.	519.	5.2	2.3	6.9	31.8	203.
	28...	Chill and Fever....................................	11 A M	92	28	101°.7	104°.	...	....	....	......	......	......	......	......	......	....
	28...	Chill and Fever....................................	9 P M	96	26	104°.	104.8	...	....	....	......	......	......	......	......	......	....
	29...	Intermission	8 A M	80	...	100°.8	101.2	22	35,607	Orange..	1005.	363.	5.3	......	10.8	21.3	88.5
	29...	Intermission......	11 A M	...	...	....	....	3	3,187	Orange..	1012.	80.	1.2	6.7	3.8	6.4	8.8
	29...	Intermission	10 P M	80	20	100.6	100.8	11	5,461	Orange..	1020.	220.	6.1	......	12.8	14.7	12.8
	30...	Intermission	9 P M	76	16	99.3	100.2	...	....	....	......	......	......	......	......	......	....
	31...	Intermission	11 A M	76	16	99.5	99.7	24	15,986	Orange..	1015.	586.	5.3	......	40.3	......	59.71
	August 1...	Intermission	10 A M	72	16	96.8	101°.1	24	28,453	Orange..	1009.	466.	2.8	......	36.9	37.8	110.5
	2...	Intermission	10 A M	66	16	98.3	99.7	24	28,280	Orange..	1010.	547.	2.8	......	30.1	31.4	160.3
	3...	Intermission	10 A M	86	22	98.3	100.8	24	27,802	Orange..	1009.	445.	3.4	......	26.4	57.0	112.4
594	August 21...	Intermittent Fever, (Fever)..................	11 A M	94	28	106°.6	106.9	10	7,794	Orange..	1011.	......	......	......	2.9	10.0	70.5
	22...	Intermission	12 M	66	22	100°.4	101.	14	9,601	Orange..	1016.	......	......	......	29.0	19.2	59.8
	23...	Intermission	12 M	80	24	....	101.3	24	12,927	Orange..	1026.	......	......	......	[illegible]	43.54	100.8

595	July	21...	Intermittent Fever, (Fever)	12 M	130	36	105°.7	104,°7	12	4,078	Yellow..	1019.	86.8	......	......	0.9	4.5	43.7
		22...	Fever and Intermission	2 P M	76	...	....	....	24	10,496	Orange..	1026.	557.	......	......	43.7	61.8	14.1
		24...	Intermission	2 P M	70	20	99°.7	100.°	24	6,748	Orange..	1021.	327.	......	12.9	20.6	17.2	13.1
		25...	Intermission	2 P M	...	...	....	....	24	11,609	Orange..	1017.	414.	......	16.23	27.2	14.5	66.4
		27...	Intermission	2 P M	...	...	....	....	24	15,610	Orange..	1017.	436.	......	......	31.8	12.8	132.0
596	August	20...	Intermittent Fever, Intermission	9 P M	88	24	....	....	20	16,761	Red......	1014.	......	......	......	34.6	25.2	92.7
		22...	Intermittent Fever, Intermission	9 P M	64	20	....	....	24	23,614	Red......	1007.	......	......	......	33.3	24.6	86.9
		23...	Intermittent Fever, Intermission	9 P M	76	...	....	....	24	10,210	Red......	1020.	......	......	......	43.41	23.4	19.8
597	July	21...	Intermittent Fever, (Fever)	1 P M	100	24	98°.3	105°.5	24	10,705	Red......	1022.	510.	6.5	13.0	32.9	34.1	17.4
		22...	Intermittent Fever, Intermission	....	...	...	....	....	12	4,080	Red......	1022.	196.	......	......	9.0	12.4	6.9
		23...	Intermittent Fever, Intermission	2 P M	80	...	98°.6	99°.5	24	8,763	Red......	1019.	107.	......	......	9.9	28.1	13.3
		24...	Intermittent Fever, Intermission	2 P M	84	20	97°.2	100°.1	24	9,430	Red......	1014.	335.	......	......	8.4	23.6	12.8
		26...	Intermittent Fever, Intermission	....	...	...	....	....	36	13,486	Red......	1015.	402.	......	......	12.3	17.6	16.0
		27...	Intermittent Fever, Intermission	....	...	...	....	....	24	15,86.	Red......	1007.	204.	......	......	26.14	10.8	44.7
598	July	21...	Intermittent Fever, (Fever)	11 A M	88	35	105°.8	106°.2	24	9,347	Orange..	1018.	351.	2.5	17.9	19.3	21.6	8.2
		23...	Intermittent Fever, Intermission	2 P M	76	...	100°.4	101°.9	30	19,903	Orange..	1018.	965.	......	......	43.1	131.4	8.4
		24...	Intermittent Fever, Intermission	2 P M	66	16	98°.3	100°.9	24	15,918	Orange..	1012.	617.	......	7.7	24.9	50.3	11.4
		25...	Intermittent Fever, Intermission	2 P M	...	...	....	....	24	15,950	Orange..	1014.	617.6	......	......	29.6	17.6	17.0
		26...	Intermittent Fever, Intermission	2 P M	60	12	....	....	24	11,209	Yellow..	1019.	518.	......	......	34.7	26.4	38.9
		27...	Intermittent Fever, Intermission	2 P M	68	...	....	....	24	23,028	Yellow..	1010.	612.	......	......	31.7	23.5	110.7
599	August	20...	Intermittent Fever, (Fever)	12 M	98	24	102.°2	104°.8	24	13,550	Red......	1015.	......	......	......	39.17	33.78	10.9
		23...	Intermittent Fever, Intermission	12 M	84	...	98°.8	101°.4	24	10,485	Red......	1017.	......	......	......	28.3	22.3	8.0
600	July	20...	Chronic Malarial Poisoning	1 P M	96	24	101.°5	101°.9	24	9,776	Yellow..	1110.	197.	......	12.5	10.5	11.1	27.1
		25...	Chronic Malarial Poisoning	1 P M	...	...	....	....	24	18,180	Yellow..	1010.	318.	......	......	10.5	8.1	46.5
		26...	Chronic Malarial Poisoning	1 P M	...	...	....	....	24	17,942	Yellow..	1008.	228.	......	7.02	3.8	10.4	40.7
		27...	Chronic Malarial Poisoning	1 P M	...	...	....	....	24	34,449	Yellow..	1008.	492.	......	......	10.4	13.9	92.4
		28...	....	1 P M	...	...	....	....	24	21,451	Yellow..	1005.	229.	......	......	9.24	......	133.19
	1863.																	
601	October	10...	Intermittent Fever															
		10...	Fever	12 M	92	32	92°.	102°.	...	....	....	......	......	......	......	......	......	......
		11...	Intermission	12 M	...	...	....	....	24	9,730	Orange..	1021.	273.	......	2.81	12.37	13.6	118.6
602	October	19...	Remittent Fever	11 A M	115	26	100°.	103°.	...	....	....	......	......	......	......	......	......	......
603	...		Remittent Fever	P M	120	33	103°.	105°.5	...	....	....	......	......	......	......	......	......	......
604	...		Remittent Fever	A M	125	38	103°.	105°.	...	....	....	......	......	......	......	......	......	......
605	...		Remittent Fever	A M	120	38	102°.5	106°.	...	....	....	......	......	......	......	......	......	......
606	...		Remittent Fever	P M	100	40	102°.5	105°.	...	....	....	......	......	......	......	......	......	......

INTERMITTENT FEVER.

COLD STAGE (CHILL).

No. of Case.	Date.	Hour of Day	State of Intellect, Skin, Tongue, Pulse, Respiration, Etc.	Pulse.	Respiration.	Temperature of atmos're.	Temperature of hand.	Temperature under tongue	Characters of Urine.
607	Sept. 30 1856.	1 P M	Intellect clear; tongue clean, moist, red at tip and edges; papillæ enlarged, and of a bright red color; skin cool and relaxed; pulse feeble; saliva acid.	70	22	68.0°	92.0°	99.5°	Light orange color; sp. gr. 1010; reaction strongly acid; no deposit after standing 70 hours.
	Sept. 30	5 P M	Extremities cold; head and trunk hot; pulse feeble.	108	30	74.0	91.0	105.5	Do. do.
608	Oct. 10	12½ P M	Tongue pointed, but moist, and not much redder than usual; skin of extremities cold, of head and trunk hot, and presents a purplish mottled appearance; pulse small and feeble; saliva acid.	100	26	68.0	91.5	107.0	Urine excreted during the chill clear and limpid, of a light straw color; sp. gr. 1003; reaction strongly acid; slight deposit of triple phosphate after 60 hrs.
	Oct. 10	1 P M	Do. do. do.	100	26	68.0	87.5	107.0	Do. do.
609	Oct. 14	...	Lips and fingers pale, and of a bluish color; extremities cold, whilst the trunk is hot; pulse small and feeble.	92	32	77.5	91.0	103.0	Urine excreted during the chill normal color; sp. gr. 1023.
610	...	...	Shaking violently; lips and hands look blue; pulse small, feeble and rapid; respiration full, panting and irregular.	100	36–50	71.5	92.0	104.0	
611	...	...	Do. do. do.	...	...	79.0	90.0	102.0	
612	...	...	Do. do. do.	120	22	79.0	89.0	102.25	

HOT STAGE (FEVER).

No. of Case.	Date.	Hour of Day	State of Intellect, Skin, Tongue, Pulse, Respiration, Etc.	Pulse.	Respiration.	Temperature of atmos're.	Temperature of hand.	Temperature under tongue	Characters of Urine.
613	...	...	**Pain in bones of legs; slight tenderness of epigastrium; tongue clean, moist, red at tip and edges; papillæ red and enlarged; skin hot and dry; saliva acid; pulse full.**	120	32	79.0°	103.3°	106.0°	**Color of urine light orange; sp. gr. 1011; reaction strongly acid; no deposit after 60 hours.**
	...	...	**Do. do. do.**	108	32	73.0	103.5	105.0	**Color of urine normal; sp. gr. 1020; strongly acid.**
614	...	...	**Fever subsiding; pulse full, but soft; tongue moist; skin in a profuse perspiration.**	98	...	72.0	102.5	103.0	**Orange colored; sp. gr. 1025; reaction strongly acid; no deposit after 60 hrs.**
	...	...	**Skin hot and dry.**	100	26	67.0	102.0	107.0	**Specific gravity 1015.**

		24...	Intermittent Fever, Intermission.........	2 P M	84	20	97°.2	100°.1	24	9,430	Red......	1014.	335.	......	......	8.4	23.6	12.8
		26...	Intermittent Fever, Intermission.........	....	...	...	....	....	36	13,486	Red......	1015.	402.	......	......	12,3	17.6	16,0
		27...	Intermittent Fever, Intermission.........	....	...	...	....	....	24	15,86.	Red......	1007.	204.	......	......	26,14	10,8	44,7
598	July	21...	Intermittent Fever, (Fever)..................	11 A M	88	35	105°.8	106°.2	24	9,347	Orange..	1018.	351.	2,5	17 9	19,3	21,6	8,2
		23...	Intermittent Fever, Intermission.........	2 P M	76	...	100°.4	101°.9	30	19,903	Orange..	1018.	965.	......	......	43,1	131,4	8,4
		24...	Intermittent Fever, Intermission.........	2 P M	66	16	98°.3	100°.9	24	15,918	Orange..	1012.	617.	......	7.7	24,9	50,3	11,4
		25...	Intermittent Fever, Intermission.........	2 P M	...	...	....	....	24	15,960	Orange..	1014.	617.6	......	......	29,6	17.6	17,0
		26...	Intermittent Fever, Intermission.........	2 P M	60	12	....	....	24	11,209	Yellow..	1019.	518.	......	......	34,7	26,4	38,9
		27...	Intermittent Fever, Intermission.........	2 P M	68	...	....	....	24	23,028	Yellow..	1010.	612.	......	......	31,7	23 5	110,7
599	August	20...	Intermittent Fever, (Fever)..................	12 M	98	24	102.°2	104°.8	24	13,550	Red......	1015.	......	......	......	39.17	33,78	10,9
		23...	Intermittent Fever, Intermission.........	12 M	84	...	98°.8	101°.4	24	10,485	Red......	1017.	......	......	......	28.3	22,3	8,0
600	July	20...	Chronic Malarial Poisoning	1 P M	96	24	101.°5	101°.9	24	9,776	Yellow..	1110.	197.	......	12.5	10.5	11.1	27.1
		25...	Chronic Malarial Poisoning	1 P M	...	...	....	....	24	18,180	Yellow..	1010.	318.	......	......	10.5	8.1	46.5
		26...	Chronic Malarial Poisoning	1 P M	...	...	....	....	24	17,942	Yellow..	1068.	228.	......	7.02	3.8	10.4	40.7
		27...	Chronic Malarial Poisoning	1 P M	...	...	....	....	24	34,449	Yellow..	1008.	492.	......	......	10.4	13.9	92.4
		28...	....	1 P M	...	...	....	....	24	21,451	Yellow..	1005.	229.	......	......	9.24	......	133.19
	1863.																	
601	October	10...	Intermittent Fever															
		10...	Fever	12 M	92	32	92°.	102°.	...	....	....	......	......	......	......	......	......	......
		11...	Intermission........................	12 M	...	...	....	....	24	9,730	Orange..	1021.	273.	......	2.81	12.37	13.6	118.6
602	October	19...	Remittent Fever..................................	11 A M	115	26	100°.	108°.	...	....	....	......	......	......	......	......	......	......
603	...		Remittent Fever..................................	P M	120	33	103°.	105°.5	...	....	....	......	......	......	......	......	......	......
604	...		Remittent Fever..................................	A M	125	38	103°.	105°.	...	....	....	......	......	......	......	......	......	......
605	...		Remittent Fever..................................	A M	120	38	102°.5	106°.	...	....	....	......	......	......	......	......	......	......
606	...		Remittent Fever..................................	P M	100	40	102°.5	105°.	...	....	....	......	......	......	......	......	......	......

INTERMITTENT FEVER—CONTINUED.

INTERMISSION.—CONTINUED.

No. of Case.	DATE.	HOUR OF DAY	STATE OF INTELLECT, SKIN, TONGUE, PULSE, RESPIRATION, ETC.	Pulse.	Respiration.	Temperature of atmosp're	Temperature of hand.	Temperature under tongue	CHARACTERS OF URINE.
625	Oct. 7 1856.	1 P M	Tongue clean and normal. Two days ago, had high fever.	64	20	73.0°	94.5°	99.0°	Normal color; sp. gr. 1030; reaction alkaline in 16 hours, and heavy light-yellow deposit of urates and phosphates.
	Oct. 8	...	Do. do. do.	52	24	73.0	98.2	99.5	Alkaline reaction, and heavy deposit in 14 hours.
626	Aug. 21	...	Two days before, had high fever. Tongue and skin moist.	72	17.5	80.0	96.0	98.0	Sp. gr. 1009; alkaline, and heavy deposit in 16 hours.
627	Sept. 14	...	Had fever on the preceding day. Tongue and skin moist.	65	24	85.0	96.0	98.0	Sp. gr. 1021; alkaline, and heavy deposit in 20 hours.

REMITTENT FEVER.

COLD STAGE (CHILL).

No. of Case.	DATE.	HOUR OF DAY	STATE OF INTELLECT, SKIN, TONGUE, PULSE, RESPIRATION, ETC.	Pulse.	Respiration.	Temperature of atmosp're	Temperature of hand.	Temperature under tongue	CHARACTERS OF URINE.
628	Oct. 9	...	Pulse very feeble, resembles the vibrations of a fine thread, with difficulty counted; respiration accelerated and irregular; lips and fingers blue; reaction of saliva intensely acid; extremities cold; tongue dry and red.	92	...	75.0	83.0	101.5	High colored, like new Madeira Wine; sp. gr. 1022; strongly acid; amount of iron increased; no deposit after 60 hours.
629	Oct. 6	...	Respiration rapid, thoracic, panting; extremities cold; tongue dry, red and rough; saliva strongly acid.	110	45	70.0	97.0	104.0	High colored, dark brownish red; strongly acid; sp. gr. 1020; iron increased; no deposit after 70 hours.

REMITTENT FEVER—CONTINUED.

HOT STAGE (FEVER).

630	Sept. 10 1856.	7 P M	Tongue pointed and red at tip and edges, superior portion coated with black fur, dry and rough; skin hot, dry and rough; great thirst, and pain in head; reaction of saliva strongly acid; pulse full.	90	48	80.0°	103.0°	105.0°	High colored, like new Madeira Wine; sp. gr. 1020; iron increased.
	Sept. 11	11 A M	Tongue red, dry and glazed; skin dry, hot and harsh; no pain of epigastrium; intellect dull; face as red as scarlet.	88	34–40	82.0	103.2	105.0	Reaction strongly acid; after stand'g 48 h's. threw down a small deposit of regularly formed crystals of triple phosphates.
	Oct. 15	7 P M	Do. do. do.	90	40–44	81.0	104.0	104.8	Do. do. do.
631	Oct. 15	12 M	Lips and tongue dry, red and rough; epigastrium very tender upon pressure; skin dry and hot; pulse rather feeble; respiration full and irregular; intellect dull; saliva strongly acid.	106	30–40	74.0°	101.0°	105.0°	Urine high colored, of a deep brownish red color; sp. gr. 1028; strongly acid.
632	...	...	Intellect torpid; aroused with difficulty; apex of tongue, for about half an inch, clean, red and dry; the remainder of the tongue is coated with rough, dry, brownish-black and yellow fur; no tenderness of epigastrium; skin hot, dry and rough.	90	30	74.0	105.0	106.0	Deep orange color; strongly acid; sp. gr. 1020; no deposit after 60 hours; still acid.
633	Sept. 16	7 P M	Face as red as scarlet; lies in a stupor; skin in a profuse perspiration; tip and middle of tongue clean, and of a bright red color; root of tongue coated with yellow fur; tongue rough and perfectly dry; when the finger is passed over the tongue, it feels as dry and as rough as a board; great tenderness upon pressure of epigastrium.	100	24	88.0	102.0	103.2	Unusual secretion of urine; the amount much larger than usual in remittent fever; specific gravity correspondingly diminished; orange colored; sp. gr. 1008; strongly acid; no deposit.
	Sept. 18	12 M	Tongue presents the same appearance; continues in a stupor; pulse feeble.	98	32	87.0	103.0	104.0	Light straw colored; sp. gr. 1010; reaction strongly acid.
634	Aug. 7	11 A M	Skin hot, but in a profuse perspiration; tongue coated with yellow fur, dry and rough; lies in a stupor.	112	38	81.0	103.0	104.0	Reddish-orange colored; sp. gr. 1013; reaction strongly acid.
	Aug. 11	10 A M	Continues stupid, and almost insensible; passes urine and feces in bed; body has a peculiar, disagreeable smell; tongue coated and dry.	132	47	80.0	104.0	105.0	Urine normal in color; sp. gr. 1011.3

INTERMITTENT FEVER—Continued.

INTERMISSION.—Continued.

No. of Case.	Date.	Hour of Day	State of Intellect, Skin, Tongue, Pulse, Respiration, Etc.	Pulse.	Respiration.	Temperature of atmosp're	Temperature of hand.	Temperature under tongue	Characters of Urine.
625	Oct. 7 1856.	1 P M	Tongue clean and normal. Two days ago, had high fever.	64	20	73.0°	94.5°	99.0°	Normal color; sp. gr. 1030; reaction alkaline in 16 hours, and heavy light-yellow deposit of urates and phosphates.
	Oct. 8	...	Do. do. do.	52	24	73.0	98.2	99.5	Alkaline reaction, and heavy deposit in 14 hours.
626	Aug. 21	...	Two days before, had high fever. Tongue and skin moist.	72	17.5	80.0	96.0	98.0	Sp. gr. 1009; alkaline, and heavy deposit in 16 hours.
627	Sept. 14	...	Had fever on the preceding day. Tongue and skin moist.	65	24	85.0	96.0	98.0	Sp. gr. 1021; alkaline, and heavy deposit in 20 hours.

REMITTENT FEVER.

COLD STAGE (CHILL).

No. of Case.	Date.	Hour of Day	State of Intellect, Skin, Tongue, Pulse, Respiration, Etc.	Pulse.	Respiration.	Temperature of atmosp're	Temperature of hand.	Temperature under tongue	Characters of Urine.
628	Oct. 9	...	Pulse very feeble, resembles the vibrations of a fine thread, with difficulty counted; respiration accelerated and irregular; lips and fingers blue; reaction of saliva intensely acid; extremities cold; tongue dry and red.	92	...	75.0	83.0	101.5	High colored, like new Madeira Wine; sp. gr. 1022; strongly acid; amount of iron increased; no deposit after 60 hours.
19	Oct. 6	...	Respiration rapid, thoracic, panting; extremities cold; tongue dry, red and rough; saliva strongly acid	110	45	70.0	97.0	104.0	High colored, dark brownish red; strongly acid; sp. gr. 1020; iron increased; no deposit after 70 hours.

630	Sept. 10 1856.	7 P M	Tongue pointed and red at tip and edges, superior portion coated with black fur, dry and rough; skin hot, dry and rough; great thirst, and pain in head; reaction of saliva strongly acid; pulse full.	90	48	80.0°	103.0°	105.0°	High colored, like new Madeira Wine; sp. gr. 1020; iron increased.
	Sept. 11	11 A M	Tongue red, dry and glazed; skin dry, hot and harsh; no pain of epigastrium; intellect dull; face as red as scarlet.	88	34–40	82.0	103.2	105.0	Reaction strongly acid; after stand'g 48 h's. threw down a small deposit of regularly formed crystals of triple phosphates.
	Oct. 15	7 P M	Do. do. do.	90	40–44	81.0	104.0	104.8	Do. do. do.
631	Oct. 15	12 M	Lips and tongue dry, red and rough; epigastrium very tender upon pressure; skin dry and hot; pulse rather feeble; respiration full and irregular; intellect dull; saliva strongly acid.	106	30–40	74.0°	101.0°	105.0°	Urine high colored, of a deep brownish red color; sp. gr. 1028; strongly acid.
632	...	...	Intellect torpid; aroused with difficulty; apex of tongue, for about half an inch, clean, red and dry; the remainder of the tongue is coated with rough, dry, brownish-black and yellow fur; no tenderness of epigastrium; skin hot, dry and rough.	90	30	74.0	105.0	106.0	Deep orange color; strongly acid; sp. gr. 1020; no deposit after 60 hours; still acid.
633	Sept. 16	7 P M	Face as red as scarlet; lies in a stupor; skin in a profuse perspiration; tip and middle of tongue clean, and of a bright red color; root of tongue coated with yellow fur; tongue rough and perfectly dry; when the finger is passed over the tongue, it feels as dry and as rough as a board; great tenderness upon pressure of epigastrium.	100	24	88.0	102.0	103.2	Unusual secretion of urine; the amount much larger than usual in remittent fever; specific gravity correspondingly diminished; orange colored; sp. gr. 1008; strongly acid; no deposit.
	Sept. 18	12 M	Tongue presents the same appearance; continues in a stupor; pulse feeble.	98	32	87.0	103.0	104.0	Light straw colored; sp. gr. 1010; reaction strongly acid.
	Aug. 7	11 A M	Skin hot, but in a profuse perspiration; tongue coated with yellow fur, dry and rough; lies in a stupor.	112	38	81.0	103.0	104.0	Reddish-orange colored; sp. gr. 1013; reaction strongly acid.
	Aug. 11	10 A M	Continues stupid, and almost insensible; passes urine and feces in bed; body has a peculiar, disagreeable smell; tongue coated and dry.	132	47	80.0	104.0	105.0	Urine normal in color; sp. gr. 1011.3

REMITTENT FEVER—CONTINUED.

REMISSION.

No. of Case.	Date.	Hour of Day.	State of Intellect, Skin, Tongue, Pulse, Respiration, Etc.	Pulse.	Respiration.	Temperature of atmosp're.	Temperature of hand.	Temperature under tongue	Characters of Urine.
635	Sept. 12 1856.	12 M	Tongue very red, but softer and moister than during the fever; the dry, yellow and brown fur has commenced to clean off; slight tenderness of epigastrium.	70	26–36	83.0°	100.7°	102:5°	Urine high colored, brownish-red; sp. gr. 1019; reaction decidedly acid; after 48 hours, small deposit of vegetable cells, urate of soda, and triple phosphate.
	Sept. 12	9 P M	Skin moist and relaxed; tongue softer and not so red; pulse regular and soft.	70	53	83.0	99.1	101.5	Brownish-red; sp. gr. 1020; strongly acid.
	Sept. 13	11 A M	Tongue continues to improve.	52	48	85.0	97.0	100.0	Orange colored; sp. gr. 1024; reaction alkaline; heavy deposit of the urates and phosphates in 15 hours.
	Sept. 14	1 P M	Tongue and skin normal.	58	28	87.0	99.0	102.0	Orange colored; sp. gr. 1025; reaction alkaline; heavy deposit of urates and phosphates in 15 hours.
636	Oct. 16	...	Intellect restored; tongue red, but soft and moist; skin dry, but soft; saliva strongly acid.	84	16	69.5	99.0	99.5	Deep orange red; strongly acid; after standing 15 hours, slight deposit of mucus corpuscles; after 100 hours, small light yellow deposit of mucus corpuscles, urate of ammonia, and vegetable cells.
637	Oct. 16	12 M	Tongue moister and softer, not so red as in fever; posterior portion still coated with brownish-yellow fur.	75	20	70.0	101.3	101.5	Bright red color; sp. gr. 1020; after standing 15 hours, slight deposit of urates and phosphates.

INTERMISSION.

No. of Case.	Date.	Hour of Day.	State of Intellect, Skin, Tongue, Pulse, Respiration, Etc.	Pulse.	Respiration.	Temperature of atmosp're.	Temperature of hand.	Temperature under tongue	Characters of Urine.
	Sept 16	8 P M	Skin cool, moist and relaxed; tongue soft and moist, but slightly redder than normal.	47	28	87.0°	95.9°	99.0°	Shade higher colored than normal; after 12 hours, heavy deposit of urates and phosphates: sp. gr. 1019.
	Sept. 17	11 A M	Do. do. do.	44	24	84.0	96.0	99.0	Reaction alkaline in 16 hrs, with heavy deposit of urates and phosp's; sp. gr. 1018.
	Sept. 18	12 M	Pulse, skin and tongue normal.	44	24	86.0	96.2	99.0	Color normal; great increase of uric acid; in 8 hours, heavy deposit of urates and [illegible]

CONGESTIVE FEVER.

643	Oct. 17 1856.	11 A M	Intellect wandering; tongue dry, hard and rough, and coated with dry, brownish-yellow fur; pulse very feeble; skin cool upon trunk and extremities.	124	28	...	...	...	Clear amber colored; sp. gr. 1015; reaction strongly acid; after standing 60 hours, the reaction was still decidedly acid.
	Oct. 18	11 A M	Intellect wandering; tongue continues still as dry and as rough as a board; pulse exceedingly feeble; trunk and head cool; skin covered with cold, clammy sweat; saliva strongly acid; respiration spasmodic; teeth coated with sordes.	155	34	...	...	...	The urine contained no urea, and no uric acid.
	Oct. 18	9½ P M	Do. do. do.	135	32	...	...	...	After 90 hours, no deposit.
644	Oct. 10	½ P M	Tongue perfectly dry and rough, feels like sand-paper; bright red color.	130	46	68.5°	100.0°	106.0°	
	...	....	Severe vomiting and purgation; skin of head and extremities bathed in cold clammy sweat.	94	22	71.0	79.0	97.0	Urine light colored; sp. gr. 1020; urea and uric acid greatly diminished; reaction strongly acid.
5	Aug. 21	1 P M	Severe pain in head; tongue thickly coated with yellow and black fur, tip and edges clean, and of a scarlet color; dry and rough.	92	39	80.0	89.0	97.0	
	Aug. 22	12 M	Do. do. do.	112	52	81.0	99.0	104.0	
	Aug. 23	12 M	Do. do. do.	72	34	78.0	89.0	96.0	
	Aug. 26	12 M	Pulse very feeble; skin of trunk and head cool; tongue dry, rough and coated.	120	22	71.0	95.5	98.0	Urine orange colored, several shades higher than in health, but much less highly colored than usual in severe cases of Malarial Fever; sp. gr. 1009; contained no uric acid.
	27	12 M	Do. do. do.	120	24	87.0	98.0	98.5	Do. do. do.
	..	7 P M	Do. do. do.	140	40	83.0	90.0	97.0	Do. do. do.

CONGESTIVE FEVER—CONTINUED.

No. of Case.	Date.	Hour of Day	State of Intellect, Skin, Tongue, Pulse, Respiration, Etc.	Pulse.	Respiration.	Temperature of atmosp're.	Temperature of hand.	Temperature under tongue	Characters of Urine.
647	Sept. 29 1856.	11 A M	Tongue slightly coated with yellow fur, dry and harsh to the feeling; intellect stupid; pulse very feeble, with difficulty counted.	112	18	80.0°	95.1°	97.0°	
	...	7 P M	Do. do. do.	140	34	...	...	...	Bright red color; sp. gr. 1016; strongly acid.
	Sept. 30	2½ P M	Do. do. do.	112	17	73.0	91.0	96.0	Do. do. do.
	Oct. 1	2 P M	Restless and stupid; tongue the same.	100	16	79.0	88.5	94.5	Do. do. do.
	Oct. 4	2 P M	Do. do. do.	120	24	76.0	100.5	...	Do. do. do.
	Oct. 5	2 P M	Restless and stupid; skin hot, dry and rough.	118	24	73.0	100.0	104.0	Do. do. do.
	Oct. 10	4 P M	Do. do. do.	130	28	70.0	103.7	104.5	Do. do. do.
648	Sept, 3	12 M	Tongue red, dry and rough; skin of extremities and trunk cold.	140	28	75.0	94.5	99.0	Could not be determined on account of restlessness and stupor of the patients.
	...	3½ P M	Lies with mouth and eyes open, and is insensible; skin in a profuse perspiration.	128	33	78.0	101.0	102.0	
	Sept. 4	12 M	Skin covered with a clammy sweat, resembling bloody serum passes urine and fæces in bed.	106	26	81.0	100.0	101.0	
	Sept. 5	10 A M	Lies in a stupor, and emits a barking sound; muscles of body twitching violently.	144	42	79.0	103.0	104.0	
	Sept. 6	10 A M	Do. do. do.	140	38	80.0	105.0	106.0	
649	...	...	Lies in a profound stupor; great tenderness of epigastrium; skin dry and rough.	140	40	70.0	104.0	104.5	
650	Oct. 12	12 M	Intellect wandering; pulse feeble; tip of tongue clean and of a bright red color, the remaining portion coated with yellow fur, dry, rough and harsh as sand-paper.	137	32	...	...	...	
	Oct. 13	11 A M	Do. do. do.	144	30	77.0	103.5	104.5	
651	Sept. 3	12 M	Intellect wandering; delirious and violent; tongue coated and dry; pulse feeble; respiration thoracic; skin dry.	140	36	75.0	102.0	104.0	
	[illegible]	[illegible]	Do. [illegible] skin in a profuse perspiration.	120	[illegible]	[illegible]	[illegible]	[illegible]	

Liver.—Yellow color and bloodless, resembling this organ in fatty degeneration, but firmer and denser in structure. Under the microscope, textures of the liver infiltrated with oil; secretory cells of liver contain much oil. The liver of uncomplicated Yellow Fever, as far as my observations extend, and according to the observations of Louis and many others, is of a bright yellow color. It is probable that this color, as in the case of the malarial liver, varies with the length of the attack and the effects of previous diseases. Thus, Dr. Samuel Jackson, of Philadelphia, found the livers of those who had died in the early stages engorged with blood. The decoction of the Yellow Fever liver is of a golden yellow color, whilst that of the malarial liver is of a brownish yellow color. The golden yellow color of the Yellow Fever liver can be extracted both by Alcohol and water. The Yellow Fever liver is firmer and harder than that of Malarial Fever, contains much less blood, and is much less readily acted upon by liquor potassæ and acids. Liquor potassæ readily dissolves the Malarial Fever liver, and the decoction presents the appearance of venous blood, while no such effect is produced by the action of this alkaline solution upon the Yellow Fever liver.

Chemical analysis reveals the presence of urea and fat in abnormal amounts; animal starch and grape sugar are also present in the Yellow Fever liver. As a general rule grape sugar is absent from the malarial liver.

ministration of purgatives, and it was frequently observed that the injection of the blood-vessels was greatest in the dependent portions of the intestines. In several cases Brunner's glands in the duodenum were enlarged and distinct. The solitary glands of the small intestines appeared in many cases enlarged and distinct. Peyer's glands were uniformly free from any well-marked morbid alteration. In some cases they were distinct and well defined in their outline, and presented a honey-comb surface, dotted with dark points; but they were always free from marks of inflammation and even of irritation, and in their pale, white color contrasted strongly with the surrounding mucous membrane, discolored with bile and often irregularly injected with blood.

Liver.—The weight of the liver is increased in Malarial Fever above the standard of health. This increase of weight is due in part to the stagnation and accumulation of blood in the capillaries and blood-vessels, and to the deposit of pigment matter in the structures of the liver. This observation applies to the liver in the acute stages.

In all the different forms of Malarial Fever, intermittent, remittent and congestive, which had continued longer than five days, and in which there had been no previous alterations of the structures, as in cirrhosis and fatty degeneration, I found the exterior of a slate color, and the interior of a bronze color. In that form of cirrhosis of the liver which is directly induced by the prolonged action of the malarial poison, the liver is in like manner of a slate color upon the exterior, and olive green within, and loaded with dark pigment granules. The change in the color appears to be very persistent, and in several cases I have observed the liver to retain shades of light slate and light bronze several weeks, and even months, after the relief of the attack of Malarial Fever, the patients having been destroyed by other diseases or by violence. The liver, especially in the peripheral portions of the lobules, contains pigment granules, resulting from the alteration of the colored blood-corpuscles and the hæmatin. The pigment granules are frequently distributed uniformly through both the portal and hepatic systems of capillaries. There is no accumulation of oil globules, as in the Yellow Fever liver. If Malarial Fever precedes or succeeds Yellow Fever, the liver may contain both oil globules and pigment granules.

The peculiar color of the Malarial liver can to a certain extent be extracted by boiling-water, and the filtered decoction presents a brownish mahogany color, from the presence of the dark coloring matters of the pigment granules; the decoction of the Yellow Fever liver, on the other hand, presents a golden color. The blood issuing from the cut surface of the malarial liver presents a dark purplish hue, and does not change to a brilliant scarlet, as in the Yellow Fever liver. Upon chemical

Heart.—Pale yellow and brownish yellow, as if undergoing fatty degeneration; structures of heart flabby and somewhat softened; numerous oil-globules deposited within and around the muscular fibrillæ of the heart. Cavities of the heart, in many cases, filled with dark fluid blood; yellow fibrinous clots sometimes present. Blood contains abnormal amounts of urea and extractive matters and ammonia. Fibrin of blood greatly diminished in amount. I have determined, both by chemical analysis and microscopical examination, that the heart undergoes acute fatty degeneration in Yellow Fever. As far as my observations have extended, the heart undergoes more rapid and extensive degeneration in Yellow Fever, than in any other acute disease. The acute fatty degeneration of the heart in Yellow Fever should not be confounded with similar changes observed in spirit drinkers and in certain chronic diseases.	*Heart.*—Normal in color, presents the deep purplish red muscular appearance of the healthy heart. Muscular fibres of the heart firm and of normal appearance under the microscope. No deposits of oil in the muscular structures. Cavities of the heart frequently distended with dark blood. Firm laminated, fibrinous concretions very common: and in some cases of Pernicious Fever, the formation of these heart-clots during the cold stage without doubt causes death, and renders unavailing the action of remedial agents. The fibrinous concretions are not only attached to the carneæ columnæ and chordæ tendineæ, and auriculo ventricular valves, but they also frequently send forth long branches into the pulmonary arteries. The formation of these concretions is rare in Yellow Fever, and when formed they are much smaller and softer than in Malarial Fever. The blood of Malarial Fever contains more fibrin, fewer colored corpuscles, and changes more slowly to the arterial hue, upon exposure to the atmosphere, than the blood of Yellow Fever.
Lungs.—Dependent portions greatly congested; otherwise normal. In some cases circumscribed effusions of blood in textures of lungs.	*Lungs.*—Dependent portions congested with blood; otherwise healthy.
Stomach.—Mucous membrane of stomach in many cases intensely congested, softened and eroded. Stomach often contains large quantities of black vomit. Reaction of black vomit often *alkaline* from the presence of *ammonia*, resulting from the decomposition of *urea*, eliminated by the gastro-intestinal mucous membrane. *Ammonia* and *urea* present in the black vomit ejected during life, and also when examined almost immediately after death. The presence of ammonia in the stomach and black vomit was not the result of post-mortem putrefactive changes. In many cases ammonia was present in such large amount, that when a rod, dipped in hydrochloric acid, was held over the mucous membrane of the stomach, or over the black vomit, dense fumes of chloride of ammonium were formed, as if the rod had been held over a bottle containing liquor ammoniæ. Chemical analysis revealed the presence of ammonia and also of urea in the black vomit. Under the microscope the black vomit was seen to contain colored blood-corpuscles, and cells of the mucous membrane of the stomach and broken capillaries. In some cases vibriones and fungi were numerous in the black vomit; in others they were absent.	*Stomach.*—Mucous membrane often presents a normal appearance; sometimes ecchymosed; rarely inflamed or softened; sometimes discolored with bile; rarely contains black vomit (altered blood). Reaction of mucous membrane of stomach and intestines acid. The pathological alterations of the stomach, observed after death, do not correspond, as a general rule, with the severity of the symptoms, the vomiting and pain on pressure during the progress of the fever. The injection of the blood-vessels, and the mottled, purplish brownish red color, after death, appear to be indicative, not of inflammation, but rather of stagnation and accumulation of the blood in the capillaries, consequent upon the disturbance of the relations of the blood to the capillaries. The distressing vomiting, so often a troublesome symptom in Malarial Fever, appears to depend upon the contact of the altered bile and the irritation of the nervous centres, which supply the stomach with nervous force, by the altered blood and by the malarial poison. In cases where there has been chronic inflammation of the stomach before the appearance of the fever, and in cases of long standing, where the solids and fluids were permanently altered, decided lesions of structure were found in the stomach. It may be asserted, however, that there is no constant or characteristic lesion of the stomach in Malarial Fever.
Intestines.—As a general rule dark-colored and distended with gas. In some cases the reaction of the intestinal contents was strongly alkaline from the presence of ammonia.	These remarks apply also to the small intestines. The mucous membrane frequently presented a purplish, irregularly injected, mottled appearance, especially after the ad-

Liver.—Yellow color and bloodless, resembling this organ in fatty degeneration, but firmer and denser in structure. Under the microscope, textures of the liver infiltrated with oil; secretory cells of liver contain much oil. The liver of uncomplicated Yellow Fever, as far as my observations extend, and according to the observations of Louis and many others, is of a bright yellow color. It is probable that this color, as in the case of the malarial liver, varies with the length of the attack and the effects of previous diseases. Thus, Dr. Samuel Jackson, of Philadelphia, found the livers of those who had died in the early stages engorged with blood. The decoction of the Yellow Fever liver is of a golden yellow color, whilst that of the malarial liver is of a brownish yellow color. The golden yellow color of the Yellow Fever liver can be extracted both by Alcohol and water. The Yellow Fever liver is firmer and harder than that of Malarial Fever, contains much less blood, and is much less readily acted upon by liquor potassæ and acids. Liquor potassæ readily dissolves the Malarial Fever liver, and the decoction presents the appearance of venous blood, while no such effect is produced by the action of this alkaline solution upon the Yellow Fever liver.

Chemical analysis reveals the presence of urea and fat in abnormal amounts; animal starch and grape sugar are also present in the Yellow Fever liver. As a general rule grape sugar is absent from the malarial liver.

ministration of purgatives, and it was frequently observed that the injection of the blood-vessels was greatest in the dependent portions of the intestines. In several cases Brunner's glands in the duodenum were enlarged and distinct. The solitary glands of the small intestines appeared in many cases enlarged and distinct. Peyer's glands were uniformly free from any well-marked morbid alteration. In some cases they were distinct and well defined in their outline, and presented a honey-comb surface, dotted with dark points; but they were always free from marks of inflammation and even of irritation, and in their pale, white color contrasted strongly with the surrounding mucous membrane, discolored with bile and often irregularly injected with blood.

Liver.—The weight of the liver is increased in Malarial Fever above the standard of health. This increase of weight is due in part to the stagnation and accumulation of blood in the capillaries and blood-vessels, and to the deposit of pigment matter in the structures of the liver. This observation applies to the liver in the acute stages.

In all the different forms of Malarial Fever, intermittent, remittent and congestive, which had continued longer than five days, and in which there had been no previous alterations of the structures, as in cirrhosis and fatty degeneration, I found the exterior of a slate color, and the interior of a bronze color. In that form of cirrhosis of the liver which is directly induced by the prolonged action of the malarial poison, the liver is in like manner of a slate color upon the exterior, and olive green within, and loaded with dark pigment granules. The change in the color appears to be very persistent, and in several cases I have observed the liver to retain shades of light slate and light bronze several weeks, and even months, after the relief of the attack of Malarial Fever, the patients having been destroyed by other diseases or by violence. The liver, especially in the peripheral portions of the lobules, contains pigment granules, resulting from the alteration of the colored blood-corpuscles and the hæmatin. The pigment granules are frequently distributed uniformly through both the portal and hepatic systems of capillaries. There is no accumulation of oil globules, as in the Yellow Fever liver. If Malarial Fever precedes or succeeds Yellow Fever, the liver may contain both oil globules and pigment granules.

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Gall Bladder.—The gall bladder in Yellow Fever is, as a general rule, contracted, flaccid, small, and contains little or no bile. The amount of bile generally does not exceed 100 grains. In Malarial Fever, on the other hand, the gall bladder is, as a general rule, distended with dark, greenish, black bile. In Yellow Fever the vomiting is rarely bilious, unless in the commencement of the disease; and the black vomit contains little or no biliary matter.

The small intestines are rarely if ever discolored by bile in Yellow Fever, whilst in Malarial Fever it is common to find the gastro-intestinal mucous membrane discolored by bile.

Spleen—As a general rule but slightly enlarged. In many cases normal in size and appearance. In many cases of Yellow Fever the spleen is neither enlarged nor softened, nor altered in appearance, either upon the exterior or within. There appears to be no special alteration or destruction of the colored corpuscles in the spleen of Yellow Fever as in that of Malarial Fever. The enlargement of the spleen in fevers does not, from these observations, depend upon the diminution of the fibrin, because this element of the blood is diminished to a much greater extent in Yellow Fever than in Malarial Fever, and at the same time the spleen is enlarged to a great and marked degree in the latter. Another fact worthy of consideration in this connection is, that in Yellow Fever the colored blood-corpuscles are not specially diminished in amount, whilst in Malarial Fever they are rapidly destroyed, and this destruction appears to be greatest in the liver and spleen. In Malarial Fever both these organs are loaded with the altered blood-corpuscles and with the pigment granules resulting from the alterations of the colored corpuscles, whilst neither the spleen nor the liver in Yellow Fever afford any evidence of alterations of the colored blood-corpuscles.

Kidneys.—These organs, as a general rule, present a brownish yellow color, much lighter than that of health. They, in common with the heart and liver, contain much free fat. When thin sections of the kidneys are examined under the microscope, the Malpighian corpuscles and tubuli uriniferi are found to be filled with granular albuminoid and fibroid matter, excretory cells detached, and oil-globules. As far as my observation extends these structural alterations of the kidneys have escaped the notice of preceding observers. The importance of these changes in the kidneys cannot be overestimated, for upon them apparently depends the suppression of the urinary excretion, which is an almost universally fatal symptom. The changes in the kidneys may depend upon several causes, amongst which may be mentioned as of prime importance the alterations induced in the

examination, the malarial liver co
starch, but no grape-sugar; the Y
liver contains both substances.

Gall Bladder.—In most cases di
more than 1000 grains of thick, gr
bile, having frequently a speci
ranging from 1030 to 1037. The
abundant in Malarial Fever and is
color, and frequently contains co
epithelial cells, from the coats
bladder and biliary ducts, and
biliary tubes. In thin layers, and
to water, it presents a deeper shad
The Yellow Fever bile presents a
in thin layers and when added to

Spleen.—Enlarged, softened and
altered blood-corpuscles and pigm
les; of a dark slate color upon th
the blood of the spleen does not
the arterial hue upon exposure to
phere. In many cases the spleen
that it ruptures when the attempt
remove it from the cavity.

Kidneys.—Normal in appearance
ture, except in malarial hæmaturi
textures are congested, and dark
some cases. Occasionally slate-c
appear upon portions of the kidn

albumen and fibrin of the blood by the febrile poison, and the congestion of the capillaries induced by derangement of the vaso-motor system of nerves and by the altered blood.	
Urinary Bladder.—As a general rule the bladder contains little or no urine in Yellow Fever. The urine is of a light yellow color, without any crystalline bodies, and loaded with albumen, granular fibroid matter, urate of ammonia, casts of the tubuli uriniferi, excretory cells of the kidney. In many cases the urine is entirely suppressed for as long a period as 48 hours before death. So long as the kidneys perform their functions freely and regularly the patient may recover, even though black vomit may have appeared, but if the action of the kidneys has been arrested by structural changes, death is inevitable.	*Urinary Bladder.*—Often distended, with high colored urine, free from albumen and casts. In malarial hæmaturia the urine contains casts and blood-corpuscles, and desquamated cells of the tubuli uriniferi. Casts high colored, and often contain colored corpuscles.

After the careful study and record of the phenomena and pathological anatomy of a large number of cases of the various forms of malarial fever, I have reached the following general results.

GENERAL CONCLUSIONS CONCERNING THE RELATIONS OF THE MALIGNANT FORMS OF MALARIAL FEVER TO CEREBRO-SPINAL MENINGITIS.

1. In many cases of Malarial Fever, various disturbances of the Cerebro-Spinal Nervous System occur, as active delirium and Coma, which sometimes disappear, without leaving any manifest alterations of function or structure; and which are quickly and entirely relieved by the free and energetic administration of stimulants and Sulphate of Quinia.

It is evident that in such cases, there is neither structural alteration, nor inflammation of the Cerebro-Spinal Nervous System. The term irritation, even cannot with any propriety be applied to such phenomena, if the term be used in its ordinary sense, as related to inflammation.

2. In many cases of Malarial fever, which prove fatal, no lesions are discovered in the cerebro-spinal structures, which will account for the symptoms during life, or for the fatal termination. The truth of this assertion has been established by the post-mortem examinations, which I have at various times published in the Southern Medical and Surgical Journal, and in the Transactions of the American Medical Association. The action of the malarial poison upon the Cerebro-Spinal Nervous System, in such cases, may be compared to that of a violent alkaloid, or even mineral poison.

It is well established that in death from various violent poisons, which produce great disturbances in the functions of the nervous system, we are in many cases, unable to discover any lesions in the structures of the Cerebro-Spinal Nervous System, which could at all account for the nervous manifestations during the action of the poison.

Other causes and agents are also active in producing the nervous disturbances in Malarial Fever, as:

(*a.*) Alterations in the physical, chemical and physiological properties of the blood, induced by the direct action of the malarial poison upon the blood. This action is characterized by alteration and diminution of the fibrin, by destruction of the colored blood corpuscles, by profound changes in the relations of the blood to the absorption of oxygen, and elimination of Carbonic Acid. The altered blood itself, independent of any direct action of the malarial poison upon the nervous ganglia, may induce such alterations in the nutrition of the nerve structures, as to induce the most aggravated nervous disturbances. It is probable also, that under certain circumstances, the altered products and constituents of the blood in malarial fever and other diseases, may act as poisons to the nervous system.

(*b.*) Arrest of the functions of certain organs, as the spleen and liver.

(*c.*) Retention of certain excretions, which should be separated by the and skin, in the general mass of the circulation.

(*d.*) Re-absorption of the altered secretions and products of certain organs, *toxemic* action of these agents. Thus the re-absorption of the altered bile of fever, is attended with intense headache, vomiting and even delirium. The tion of the large mass of altered blood, in the enlarged, softened spleen of fever, must be attended with injurious results.

3. In some cases of Malarial fever, the severe nervous symptoms remain; lants and revulsives, and Sulphate of Quinia exert no effect in arresting the in arousing the patient from the state of Coma, or in relieving the convulsions delirium.

Such cases may occur at any period of the year, in those who have been to the action of malaria, but as far as my experience extends, they occur most in the autumn and winter.

Cold appears to have much to do with the production and termination of as we shall endeavor to show.

Individuals, who have the "*seeds*" of malaria in them, may even remove to regions, and pass months with only an occasional slight chill, or headache, and denly be seized with fatal symptoms, which appear to be referable chiefly to the Spinal Nervous System. In such cases in which the cerebro-spinal symptoms were ent, and terminated fatally, the true causes are found in the lesions of the blood, as of the *nervous structures*. Even in those cases of Pernicious Malarial Fever, manifested during life symptoms similar to those of Cerebro-Spinal Meningitis, I failed to detect after death fibrinous effusions, coating the membranes of the spinal cord; but on the other hand, the ventricles of the brain, and the space, were in some cases distended with fluid. It is but reasonable to this effused fluid may, in some cases of malarial fever, cause death; and at the time, it is not necessary to suppose that this effusion or fluid, in and around the structures, is due to the presence of inflammation. After the colored blood have been destroyed, and the fibrin and albumen altered, and the blood thus watery and thus altered in its most essential, physical, and chemical and properties, by the rapid, or more slow action of the Malarial poison, it is evident an effusion of the watery elements of the blood is liable to occur from the of any organ and tissue, in which there is an active determination or congestion of A prolonged *chill*, in itself, or in conjunction with the action of cold, which still increases the internal congestion, may be attended with such effusions of the Sanguinis of the blood, as permanently to impede the functions of important In like manner, (as will be fully shown in the investigations on Pneumonia,) in case of the lungs, the irritation or inflammation of a comparatively small portion of organ, in the body, upon which the malarial poison has exerted its characteristic may be attended with large serous effusions,. not only from the parts involved, by the inflammation, but from surrounding parts. We may thus certain cases at least, the sudden supervention of symptoms of compression of the without any apparent inflammation of that organ, in those laboring under the the malarial poison.

4. The functional and structural derangements of the Cerebro-Spinal Nervous tem in Malarial Fever, and under the action of the Malarial Poison, without symptoms characterized as fever, are referable to several causes:

(*a.*) The direct action of the poison upon the nervous structures.

We have regarded the action of the malarial poison in most cases, as and not inflammatory, and analogous in its action and relations to certain vegetable poisons. We must admit, however, that to determine accurately, tions of the nervous apparatus, under the action of various morbific and it is absolutely necessary that the structures of the different parts of the which we have endeavored to unfold in connection with that of Cerebro-Spinal Meningitis, should be conducted upon the same general plan, regardless of the period of the year, and the length of time which has elapsed since the exposure of the patient to the malarious poison. Quinine, stimulants, and revulsives, are the main and essential remedies in the malignant form of Malarial Fever, as has been well established by the experience of numerous practitioners. These remedies should be used immediately and freely, regardless of the cerebral symptoms, and of the presence or absence of delirium and fever. The greatest portion of these cases will be arrested, and the patient rescued from the jaws of death, by the energetic use of Quinine, in doses varying from 5 to 15 grains every two or three hours, and by the free use of diffusible stimulants, as Alcohol, Sulphuric Ether, Chloroform and Ammonia. If the sudden and severe symptoms are not arrested by the free use of Quinine and stimulants, and the patient does not die, but remains in a feeble, semi-conscious state, anti-periodics and stimulants should not be abandoned, even though we may be convinced that serous effusion has taken place around the brain and spinal cord, and in the ventricles of the brain. The anti-periodics should be continued to ward off if possible the recurrence of the congestive stage, and stimulants and nutritious diet should be given to support the strength, with the hope that the effusion may be absorbed, and the impaired cerebro-spinal structures restored. Iodide of Potassium and Iodide of Quinia, together with blisters to the back of the neck and head have proved beneficial in cases which would have terminated fatally without the use of these remedies. It is well established, that Quinine, with the various preparations of iron, with nutritious diet, and attention to the state of the liver and kidneys, and the use of such depurants as the acetates and citrates of potassa and soda, constitute the best remedies in the treatment of those who are thought to be liable, from previous attacks of Malarial Fever, to these sudden congestive attacks. Arsenic is, without doubt, a remedy of great value in obstinate cases of Malarial Fever, but its administration will not always prevent the sudden supervention of fatal symptoms. Arsenic should never supercede entirely Quinine and Iron, and during its use, due attention should be paid to the functions of the kidneys and liver; and it should be remembered that whenever it exerts its local effects upon the stomach, in producing nausea and vomiting, its constitutional effect in relieving the paroxysmal fever, is greatly impaired, if not wholly lost.

7. In Cerebro-Spinal Meningitis, on the other hand, although many of the symptoms resemble those of certain forms of malignant Malarial Fever, the nature of the lesions, and the entire pathology of the disease is different.

The changes of the blood, and of the liver and spleen, described as characteristic of Malarial Fever, form no necessary part of the history of uncomplicated Cerebro-Spinal Meningitis. The pathological phenomena are more complicated in Malarial Fever than in Cerebro-Spinal Meningitis; whilst the former disease is induced by a poison which alters the chemical and physical properties, and physiological offices of the blood, and which acts also upon the muscular and nervous structures, the latter consists essentially in a violent inflammation of the meninges, and especially of the pia-mater of the entire cerebro-spinal system.

Notwithstanding the essential differences in the characters of these two diseases, yet in many cases, and especially in the first cases of an epidemic of Cerebro-Spinal Meningitis, the physician is liable to confound the disease with malignant Malarial Fever. This similarity of symptoms is due, rather to the fact that the manifestations of depressed and aberrated nervous actions are similar in many sudden and fatal forms of disease, involving profound lesions of the blood and cerebro-spinal and sympathetic systems.

As far as our knowledge extends, the main differences between Cerebro-Spinal Meningitis and Malignant Malarial Fever, appear to be as follows:

DIFFERENCES BETWEEN THE SYMPTOMS AND PATHOLOGICAL LESIONS OF CEREBRO-SPINAL MENINGITIS AND MALIGNANT (CONGESTIVE PERNICIOUS) MALARIAL FEVER.

(*a.*) Cerebro-Spinal Meningitis more frequently commences with convulsions, and less frequently with a well marked chill, in which there is an elevation of the temperature of the trunk, and a depression of the temperature of the extremities.

(*b.*) The temperature is not subject to the periodical elevations and depressions which characterize Malarial Fever.

(*c.*) Contractions of the muscles, and persistent dilatation or contraction of the pupils of the eyes, are less frequent in Malarial Fever.

(*d.*) The pulse is more rapid, feeble, and irregular, and subject to greater hourly variations, and the respiration is more rapid, irregular and panting in malignant Malarial Fever, than in Cerebro-Spinal Meningitis, and at the same time the temperature is liable to greater variations, and the difference between the temperature of the trunk and extremities is greater, as well as the range of variations during the progress of the disease.

(*e.*) The tongue is dryer, redder and more coated in Malarial Fever.

(*f.*) The bowels are not so obstinately constipated in Malarial Fever.

(*g.*) The complexion is more generally sallow and anæmic in Malarial Fever. Jaundice is much less frequent in Cerebro-Spinal Meningitis.

(*h.*) The alterations of the blood are more profound in Malarial Fever. In Cerebro-Spinal Meningitis the fibrin is increased, and there is no destruction of the blood corpuscles, nor of the ferment, by which glucogene is transformed into glucose, as in Malarial Fever; and the tendency to passive hæmorrhages is much less in the former disease.

(*i.*) The liver and spleen are universally involved in Malarial Fever, whilst they are frequently not at all affected in Cerebro-Spinal Meningitis. The bronzed liver and large, softened, disorganized spleen of Malarial Fever, will serve to indicate to the pathological observer whether or not the epidemic of Cerebro-Spinal Meningitis be complicated with the action of malaria.

(*j*) Even in the most sudden, and malignant, and rapidly fatal forms of Malarial Fever, with the greatest marks of cerebro-spinal disturbance, no organized or organizable fibrous lymph is thrown out from the membranes of the brain, and if effusions occur, the fluid thrown out is serous, or serum colored with bile, and more rarely with the coloring matter of the blood. On the other hand, the effusion of coagulable plastic lymph is the characteristic lesion of Cerebro-Spinal Meningitis.

(*k.*) The nervous disturbances are more uniform and persistent in Cerebro-Spinal Meningitis, and do not yield, as they do in Malarial Fever, to the free use of alcoholic stimulants and Quinine.

It is not to be denied, that inflammation of one or more organs may arise in the progress of an essential fever. Pneumonia is frequently excited during the progress of Malarial Fever, just as peritonitis may arise in Typhoid Fever from perforation of the bowels; but we contend that when these inflammations arise during the progress of these fevers, they do not stand in the relation of an effect to a cause: they are in no manner essentially and uniformly the results of the action of the Malarial and Typhoid poisons.

We have also dwelt upon the important fact, that the delirium, coma, and irregular nervous actions which characterize the severer forms of Malarial Fever, Typhoid and Typhus Fevers, are not due to an inflamed condition of the cerebro-spinal nervous system, but rather to impairment of the nutrition and action of the ganglionic cells, and of the nerves generally, in consequence of the disorganization of the blood and nutritive fluids, and in consequence of the retention of noxious products resulting from the chemical changes excited by the febrile poison, and probably also in consequence of the direct action of the peculiar poisons upon the nervous elements. The delirium of fevers is frequently removed by the most active stimulation, and by the administration of alkaloids, as Quinia, which excite the nerve centres, and promote also the removal of the products of the metamorphosis of the blood and tissues.

The delirium and coma of Cerebro-Spinal Meningitis cannot thus be relieved by free stimulation, and such alkaloids as Quinia and Morphia. In a word, Cerebro-Spinal Meningitis like other acute inflammatory diseases, is characterized by an increase of fibrin in the blood, and by the formation of deposits of inflammatory lymph, capable of organization into fibro-elastic tissue.

COMPARISON BETWEEN THE CHANGES OF THE BLOOD IN CEREBRO-SPINAL MENINGITIS, AND THOSE INDUCED BY THE ACTION OF CERTAIN POISONS.

In considering the accounts which have been given by various observers, as to the condition of the blood in this disease, it is important that we should distinguish between the characters of the blood drawn by bleeding during the life of the patient, and that observed in the vessels after death. Confusion in this matter has led to false conclusions. I have adduced the testimony of competent observers, to show that the blood is not disorganized in Cerebro-Spinal Meningitis, and does not present the characters of the blood in the essential fevers. Dr. Joseph A. Gallup describes the blood as covered with an inflammatory crust or buffy coat, (Sketches of Epidemic Diseases, p. 261), and we have seen that Dr. S. Ames, of Montgomery, Alabama, found that the blood coagulated firmly in thirty-seven cases in which it was abstracted from the arm, and by cut-cups from the back and neck, and in his quantitative analyses of this fluid, the colored corpuscles were normal, whilst in all there was an excess of fibrin, the maximum being double that of health, this constituent ranging from 3.46 to 6.40 in 1000. In four cases, in which the blood was examined by Andral and Gavarret, the fibrin was found increased from 4.70 to 5.63, the normal standard being about 2.20; and the corpuscles from 134 to 143 parts in 1000, the normal standard being about 131. Mons. Maillot reports 6 cases, in which the blood was examined by Soulier, where the fibrin rose to 6 parts in 1000. Dr. J. S. Jewell says, that in all the cases which have fallen under his notice, the fibrin has been uniformly increased in quantity above the normal standard, and the same was true of the corpuscles. In one case observed by Dr. Jewell, blood was drawn the third day of the disease—it was the first bleeding; it coagulated rapidly, and with a clot, which, for size, firmness and thickness of the buffy coat, surpassed anything that Dr. Jewell had ever seen.

The objection which has been made to such examples, that the blood was probably examined after the second or third bleedings, when we would be led to expect an increase of fibrin, if it were true, as it is not, will certainly not apply to the corpuscles, since we should for the same reason look for a diminution of these organic elements. But the corpuscles show no diminution, but rather an increase above the normal standard.

M. Forget, Faure, Villaure and others, have made observations tending to establish the same facts.

On the other hand, those writers, who by their own confessions, never bled their patients, but who confined their inspections of the blood to that obtained from the large vessels *after death*, have been led into the most erroneous statements, and have used crude, superficial and untrustworthy observations, upon which to found *theories of the nature of the disease.*

Dr. James J. Levick, of Philadelphia, who may be regarded as representing the opinion of a considerable number of the physicians of that city, and of many composing "the American Medical Association," in his report on "*Spotted Fever*," thus, in *a small foot note* attempts to dispose of the observations of pathologists:

> "Dr. Ames of Montgomery, Ala., and one or two recent German writers, state that they notice an excess of fibrin in the blood of spotted fever. It may be that this was in an advanced stage of the disease, or that it was merely relatively in excess."

The question may well be asked, if Cerebro-Spinal Meningitis be a *blood disease*, an essential fever in which "the only constant pathological condition, is an altered state of the blood," why should the continuance of such an altered state of the blood during the depressing and degenerating effects of the fever, be the condition necessary to increase the plastic element of the blood?

In the report of the Committee of the American Medical Association, through Dr. Levick, as chairman, we find the statement that:

> "A specimen of blood, taken from a spotted fever patient, and examined by the committee presented the following appearances. The red corpuscles were shrivelled, crenated, not in rouleaux, and numerous white corpuscles were noticed on the field."

No history of the case from which this blood was taken is given, and we are led from the fact that Dr. Levick was opposed to blood-letting, and also from the fact that whenever the blood is spoken of as examined by himself, it evidently was taken after death, to conclude that the sample examined, was most probably altered by the post-mortem changes. After a critical examination of this report, which received the sanction of the American Medical Association, we have been unable to determine at what time after death, the examination of the blood was made. Thus it is said, that:

> "In two cases, each proving fatal in about twelve hours, the vessels of the dura-mater were found filled with dark fluid blood. * * * In these cases besides universal ecchymoses the lungs were found engorged with dark fluid blood. Soft coagula were found in the left ventricle, while in the right ventricle the blood was thin and without coagula."

It is impossible to decide from this report, the exact number of post-mortem examinations performed actually by himself or others, upon which Dr. Levick bases his generalizations; but he refers substantially to only four post-mortem examinations. And yet the assertion is made that "in every case the blood was fluid, even when death took place, in four hours was this the case."

Not a single fact is given by which any light is thrown upon the time at which the *post-mortem examinations* of the blood were made. It is well known, that the blood is found fluid in the blood-vessels, in those who have died from various diseases, even diseases of the most inflammatory character. And it is worthy of note, as shown by my own observations, that heart clots are most likely to form in the severest and most malignant forms of malarial fever, in which there is a marked diminution of the fibrin.

The condition of the blood in the vessels after death, will depend in large measure, upon the cause of death, and the condition of the vessels and tissues at the time of death, and also upon the surrounding temperature, and the period after death at which the blood was abstracted for examination.

In Cerebro-Spinal Meningitis death most frequently takes place, in consequence of the disturbances of respiration and circulation induced by the pressure of the effusion and coagulated lymph, upon the brain and especially upon the medulla oblongata; and the final issue is frequently sudden, in spasms and convulsions. In such cases the character of the blood, has undergone comparatively little change, except that which is due to the retention and action of the Carbonic Acid Gas. If we may use the expression, the tissues and organs of those suddenly cut down, are also in a perfect state, and do not rapidly undergo change, as in the case of the bodies of those who have died of malignant fevers. Dr. Gallup, long since observed, and his observation has been repeatedly confirmed, that with the resemblance to a state of mortification, there is no offensive scent, any more than with a person killed by lightning; nor is there any evidence of a weakened texture of the fibres of the skin or muscles. Now these are precisely the conditions most favorable to the preservation of the blood in a fluid state, in the vessels after death.

Upon such observations upon the blood in three or or four dead bodies, the Committee proceed to erect their theory.

> "A careful examination of the subject has left no doubt in the mind of the *Committee*, that *the disease is essentially a fever*, not essentially an *inflammation*; that local inflammations when

> they do occur, are consecutive to the constitutional disturbance, are due to the morbid condition of the blood, provoking exudation, and that their locality is determined by incidental circumstances."—Trans. Am. Med. Ass., vol. 17, 1866, pp. 330, 333.

Dr. W. W. Gerhard, from whom Dr. Levick and other physicians of Philadelphia, appear to have derived their ideas as to the nature of this disease, from the result of two post-mortem examinations of patients who had died suddenly in the earliest stages of the disease, concludes:

> "That it is strictly a blood disorder, unconnected with any structural lesion. * * Although the proof of spotted fever, being a blood disease, is to my mind conclusive, it must not be ascribed to an impoverished condition of this fluid, from innutritious or deficient food, as none of the patients whom I saw, were in a condition of actual poverty, and a large majority of them belonged to a class amply supplied with all the comforts of life."—Trans. College of Physicians, of Philadelphia, 1862–4, p. 44.

The observations of Dr. Gerhard and Levick, upon the blood abstracted after death, are not only absolutely wanting in both *Quantitative and Qualitative* data, but are also valueless when compared with the results obtained by Ames, Andral, Gavarret, and others. The same criticism will also apply to the observations of Dr. W. H. H. Githens, of Philadelphia, and to those of all pathologists who have neglected the Quantitative Analysis of the blood during life, and based their observations upon this most complex of all organic fluids upon the results of a superficial occular inspection of the blood in the dead bodies.

But even granting that the blood is fluid and dark colored, with shrivelled corpuscles in the large vessels after death, such facts furnish no proof that the disease is essentially a blood disease, and no justification for the assertion that "the only constant pathological lesion, is an altered state of the blood."

A large proportion of the cases of Cerebro-Spinal Meningitis, which terminate fatally are destroyed by the derangement of the function of respiration, resulting from the derangement of the nervous centres and nerves presiding over this function, either by a direct impairment of their functions, or by the pressure upon the nervous cells and fibres, of the products of inflammation, poured out into the closed Cerebro-Spinal cavity; and in all cases of this disease, the blood may be more or less altered by the imperfect elimination of Carbonic Acid Gas from the lungs.

In other words, after the establishment of inflammation within the Cerebro-Spinal Cavity, in this disease, the impairment of respiration is such that Carbonic Acid accumulates in the blood, especially as the disease draws nearer to a close, and this poisonous gas exerts certain effects upon the blood.

I have performed a number of experiments upon the action of various gases upon the blood of living animals, and have been able to show that Carbonic Acid Gas, whether administered artificially, or simply allowed to accumulate in the blood of the living animal, acts upon the blood corpuscles, and alters their shape; and that this is precisely the gas which produces a crenated appearance of the colored blood corpuscles.

As this is a point of some interest to pathologists, as well as physiologists, especially in its bearing upon the microscopical examination of the blood after death, we will present an account of the experiments.

EXPERIMENTS ON THE EFFECTS OF GASES ON THE BLOOD OF LIVING ANIMALS.

Carbonic Acid Gas.

Experiment 203: Salt-Water Terrapins, (Emys Terrapin,) and Yellow-bellied Terrapins, (Emys Serrata,) were placed in large receivers containing Carbonic Acid Gas. The animals took long inspirations and expirations resembling deep sighs. The noise made by the passage of the gas, in and out of their lungs, resembled that often made by human beings dying from narcotic poisoning, or congestion of the brain. The breathing of the terrapins became more and more laborious and less frequent, occurring at intervals of from ten to thirty minutes, and finally ceased in from ten to twelve hours.

The blood was of a much darker color than when the lungs were supplied with atmospheric air, and resembled the venous blood of the mammalia; upon exposure to the air, for a length of time, it became upon its exterior, of a red color. The heart, and intestines, and lungs, were engorged with black blood. The contractility of the muscles was destroyed.

The blood corpuscles had undergone remarkable changes. They were shrivelled and contorted, presenting innumerable shapes, and were entirely altered from the ordinary ellipsoid. These changes had taken place in the colored corpuscles, in all the organs and tissues of the body. The effects of the gas appeared to have been confined principally to the exterior wall of the blood corpuscles, for when they were treated with Acetic Acid, the nuclei were brought out unchanged. The urine of all these terrapins which were confined in Carbonic Acid Gas, contained grape sugar, which is not normally present in the excretions of the kidneys of these animals.

These effects upon the blood cells are not so manifest in warm-blooded animals, on account of the rapid manner in which they are destroyed by this gas.

Experiments illustrating the Action of Carbonic Acid Gas on Birds.

Experiment 204: Augusta, Ga., February 18th, 1866. A strong, active pigeon, was subjected to the action of Carbonic Acid Gas, by introducing the head into the open mouth of a receiver filled with Carbonic Acid Gas. After the first two or three inspirations, the action of the respiratory muscles, became labored and spasmodic—the mouth of the bird was thrown wide open, and the muscles of the throat were convulsed. Immediately after the manifestation of the effects upon the respiration, the action of the heart was greatly increased in force—the pulsations were so powerful, that the thermometer introduced into the rectum, was violently agitated by each impulse of the heart. The bird was killed by the Carbonic Acid Gas in 120 seconds.

Effects on Temperature. During the violent pulsations of the heart, the thermometer rose 0.05° C., and after remaining stationary for a short time commenced to descend slowly, as soon as death took place, and in five minutes after death, fell 0.55 C.; temperature of atmosphere, 10° C.; temperature of rectum before experiment, 42°. C.; temperature of rectum just before the heart ceased its violent action, 42°.05 C.; temperature of rectum 5 minutes after death, 41°.5.; 75 minutes after death, 33°.; 120 minutes after death, 29° C.; 285 minutes after death, 21° C.

Post-Mortem Examination. 24 hours after death, the blood was fluid in the blood-vessels of the brain, liver, intestines, and of all the organs, and presented a dark, venous hue. When exposed to the atmosphere, the blood changed to the arterial hue, and coagulated.

Experiment 205: January 19th, 1861. A strong, active Pigeon, was treated in a similar manner to that described in the preceding experiment, the effects of the Carbonic Acid Gas were similar, with the exception that the temperature of the rectum did not rise, but slowly descended during the action of the gas. Temperature of rectum before the administration of the gas, 42°.5 C.; during the experiment, the temperature descended 0°.05 C., and stood at 42°.45 C. at the moment of death; temperature of atmosphere, 18°.3 C.; of rectum, one hour after death, 34°.; 85 minutes after death, 32° C. *Post-Mortem Examination.* The appearances were the same as those indicated in preceding Experiment 204; blood-vessels of organs and tissues filled with black, fluid blood.

Experiments 206, 207, 208, 209, 210, 211, 212, 213, 214, 215: Repetitions of Experiments 204 and 205, with Carbonic Acid Gas, results similar. Blood-vessels after death, filled with black, fluid blood.

Carbonic Oxide Gas.

Experiment 216: Effects of Carbonic Oxide Gas on Corn-Snake, (Coluber Guttatus.) Maybank, Colonel's Island, Liberty Co., Ga., July 1855. An active Corn Snake, (Coluber Guttatus,) was placed in a glass jar containing Carbonic Oxide Gas.

At first the efforts of the serpent to escape were unceasing and violent. Gradually its respiration became more laborious; it gasped violently for breath; its motions became spasmodic and were succeeded by intervals of apparent exhaustion. It died forty-five minutes after its introduction into the gas. An examination after death, showed that the contractility of the muscular fibres had been destroyed, and that the muscles could not be excited by artificial stimuli. The heart was the last portion of the muscular system to yield to the action of the poison, it continued to beat feebly for a short time after the thorax was opened. The blood from all parts of the body was of a brilliant scarlet color, and coagulated into a dense firm clot, which was unstable and dissolved again. After the dissolution of the fibrin, the blood corpuscles settled to the bottom of the glass vessel, and the serum above was perfectly clear, and without any marked color. Under the microscope, the blood corpuscles presented no unusual appearance, when their broad surfaces were turned towards the eye; when however they were viewed edgeways, they appeared swollen, and the central nuclei, was much less distinct than in their normal condition, being scarcely visible. Acetic Acid exerted its characteristic action, first rendering the blood corpuscles dumb-bell or hour-glass in shape, when viewed edgeways, and then rendered the exterior cell-wall transparent, and revealed clearly the nuclei. When the Acetic Acid was neutralized with diluted liquor potassæ, the cell-walls were again brought into view. Concentrated liquor potassæ dissolved the blood corpuscles, with no immediate change of color. In a few moments however, the color changed to a darker red, and gradually assumed a brownish yellow color, and became as usual ropy and viscid. Vigorous streams of Carbonic Acid and of Oxygen Gases, passed through separate, and the same portions of blood, produced no change whatever in the scarlet color, or form of the blood corpuscles.

Portions of this blood were kept for several weeks, and they still retained their scarlet color, and did not undergo putrefaction.

These reactions show that the change in the color of the blood was due, not to an alteration of the forms of the blood corpuscles, but to a permanent chemical change in the coloring matter. Another effect of the Carbonic Oxide Gas, was to render the fibrin unstable. This gas arrests oxydation and the rapidity of its action, shows the great importance of this process. The vital acts are incompatible with the sudden arrest of the chemical changes and metamorphosis of the elements of the solids and fluids. If however the process of oxydation be slowly stopped, by a gradual diminution of the temperature of cold-blooded animals, the vital force is not destroyed, although the mechanical functions may be suspended.

Experiment 217 : A Bull Frog, (Rana Pipiens,) placed in a receiver containing Carbonic Oxide Gas, manifested similar phenomena as in the preceding experiment 216, but died in a much shorter time, viz : 10 minutes. This difference appeared to be due to the difference of structure in the integumentary systems of the ophidians and batrachians. The naked skin of the frog absorbed the Carbonic Oxide Gas, more rapidly than the scaly integument of the serpent. The blood presented marked changes, viz ; a brilliant scarlet hue, and instability of the fibrin.

Experiment 218 : *Action of Carbonic Oxide Gas on King Snake*, May 30th, 1861. Active King Snake (Coronella Getula,) 3 feet in length, placed in a glass jar of Carbonic Oxide Gas, mixed with one third of its volume of atmospheric air. The reptile gasped for breath, and in a few moments, the mucous membrane of the mouth, presented a beautiful pink color, showing the absorption and effects of the gas. In 15 minutes the reptile appeared to be powerfully affected and lay in a comatose state, from which it was with difficulty aroused. It gasped violently and spasmodically for breath, once or twice each minute—the mouth was thrown open, and the entire muscular system was convulsed, as it gasped. All signs of life were extinct in two hours with the exception of a slow pulsation of the heart. The heart continued to pulsate slowly and feebly for more than two hours after the thorax was opened, notwithstanding that mechanical and electrical stimuli failed to excite contractions in the voluntary muscles. The blood in all the organs and tissues presented a brilliant scarlet color.

Experiment 219 : *Action of Carbonic Oxide Gas on Pigeon*, 1861. The head of a large, active Pigeon was introduced into a receiver containing a mixture of Carbonic Oxide Gas and atmospheric air. The action of the heart, after the first two or three inspirations, was greatly increased in force. The action of the heart was so great that the thermometer in the rectum was violently agitated. In this respect the Carbonic Oxide Gas, resembled in its excitant effect upon the heart of the bird, Carbonic Acid Gas.

The action of the heart gradually subsided during the last two minutes of life, and appeared to cease altogether, before the cessation of respiration. Death took place in about 5 minutes after the introduction of the head of the bird into the receiver. The temperature of the rectum at the commencement of the experiment was 42°.75 C.; temperature of atmosphere, 18° C.; the temperature of the rectum commenced slowly to descend, from the commencement of the action of the poison, and fell 0°.25 C., during the continuance of life, and at the time of death, the temperature of the rectum stood at 42°.5 C.; 48 minutes after death, 37°.33 C.; 153 minutes, 33°.; 318 minutes, 23°.5 C.

Immediately after the inhalation of the gas, and before death, the mucous membrane of the eyes and mouth presented a beautiful scarlet hue.

Post-Mortem Examination. The skin of the most dependent portion of the body, presented a beautiful, light scarlet color. The blood in the vessels of all the organs and tissues, presented a brilliant scarlet color. No other change was observed, in the form of the colored corpuscles under the microscope, except that they were more swollen than normal. When kept for days the blood still retained its brilliant color.

Experiment 220 : Action of Carbonic Oxide Gas.

January 1860. Strong, active Pigeon ; head of bird placed in receiver, into which a stream of Carbonic Oxide Gas was flowing. The gas was almost undiluted, and its effects were immediately apparent, and the bird died in a few moments. The mucous membrane of the mouth and eyes, were changed almost immediately to a bright crimson hue. The bird died in less than one minute. Temperature of atmosphere, 18°.5 C.; temperature of rectum before inhalation of gas, 40°.7 C. The temperature commenced to descend, almost immediately after death, and at the end of 50 minutes, stood at 33°.8 C.; 75 minutes after death, 32°.33 C.

Post-Mortem Examination. Mucous membrane of the mouth, eyes, and skin of the most dependent portions of the body, of a beautiful, light carmine color. The blood in all the organs and tissues presented a brilliant carmine color.

Experiment 221: Action of Carbonic Oxide Gas on Dog, large Bitch; strong and in good condition. Action of heart, 100; respiration 35; temperature of rectum, 40°.6 C. The head of the dog was placed in a receiver containing Carbonic Oxide Gas; its effects were manifest in 2 minutes; the dog cried out as if in great pain, but there were no tetanic spasms and no struggles. Both the respiration and the actions of the heart were diminished. The respiration was only 2 per minute. At the end of 4 minutes, the respiration ceased entirely. The gas was then withdrawn; the dog excited most probably by the atmospheric air, gasped several times, stretched itself, voided fæces, and manifested signs of recovery. 10 minutes after the first application of the gas, and 6 minutes after its withdrawal, the respirations or rather gasps, were 17 per minute; action of heart 48, irregular, spasmodic and forcible—arteries beating strongly; profound coma. Temperature of rectum, 40°.4 C. The temperature commenced to descend as soon as the gas had produced decided effects. As soon as there were signs of returning consciousness, the dog was again subjected to the action of the Carbonic Oxide Gas; the same phenomena were repeated, the dog moaned piteously, the mucous membrane of the mouth, tongue, and eyes, assumed a brilliant scarlet and pink color, and profound coma, while slow action of the respiration was produced in 3 minutes, and in 6 minutes both the respiration and the action of the heart had ceased. Temperature of rectum 40°.35 C. All signs of life extinct.

The chest was opened about 5 minutes after all signs of life had vanished—the cavities of the heart were distended with scarlet blood. Vigorous artificial respiration was then instituted. The heart failed entirely to respond to either artificial respiration, mechanical stimuli, or the interrupted electric current. Peristaltic motions of the intestines could not be excited by any means, mechanical or electrical. The voluntary muscles responded slowly and feebly to the electrical stimulus. The muscles of all the organs presented a brilliant color, the blood in all parts of the body presented a brilliant scarlet color. This brilliant color presented a marked contrast to that of the blood of animals killed by various other gases, as Chlorine, Carbonic Acid, and Per-Oxide of Nitrogen.

30 minutes after death, the blood in the cavities of the heart, was found to be coagulated. 6 hours after death, rigor mortis had not taken place, and the limbs were perfectly flexible.

Experiments 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232.

Repetitions of preceding Experiments, (216–221), illustrating the action of Carbonic Oxide Gas on living animals. The results were similar. By numerous experiments, I found that Carbonic Oxide Gas produced the characteristic brilliant scarlet or carmine color in the blood of all vertebrate animals—Batrachians, Ophidians, Chelonians, Saurians, Mammals and Birds.

EXPERIMENTS ILLUSTRATING THE ACTION OF BIN-OXIDE OF NITROGEN (NITRIC OXIDE NITROSYL,) AND PER-OXIDE OF NITROGEN (NITRIC PER-OXIDE, OR HYPONITRIC ACID.)

Experiment 223. January, 1861.

A Chelonian was placed in a glass receiver containing a mixture of Bin-Oxide and Per-Oxide of Nitrogen. The first effects of the gas upon the Chelonian (Emys Serrata), appeared to be stimulating; the force and rapidity of the respirations being increased. At the expiration of 60 hours, although all signs of life had ceased, the heart still pulsated. The vessels leading to the heart, as well as the cavities of the heart itself, contained much gas. The cavities of the heart contained fibrous concretions, entirely free from colored blood corpuscles. Clots of blood were found in all the large blood-vessels. The blood presented a purplish brown and yellow color. The action of the blood was acid. Under the microscope the colored blood corpuscles were found to be greatly altered presenting contracted, shrivelled, altered forms. All the organs presented a brownish color.

Experiment 234: Illustrating the action of Bin-Oxide and Per-Oxide of Nitrogen. 1861.

Placed a Musk Tortoise (Sternothærus Odoratus), in receiver containing a mixture of Bin-Oxide and Per-Oxide of Nitrogen. Life was not destroyed until the expiration of 50 hours.

At the end of this time, its blood, and organs, and muscles presented a similar brown and purplish brown color, as in the preceding experiment (233). The blood corpuscles were greatly altered in form and appearance under the microscope.

Experiment 235: Illustrating the action of Per-Oxide and Bin-Oxide of Nitrogen on Birds.

1861. Active Pigeon; head of bird introduced into a receiver containing a mixture of Bin-Oxide and Per-Oxide of Nitrogen. Immediately upon the inhalation of these gases the effects were evident. Death ensued in 50 seconds. During the action of the gas, the temperature rose 0°.05 C., remained stationary, and then slowly descended after death.

Temperature of rectum at the commencement of the experiment, 41° C; at moment of death, 41°.05; 53 minutes after death, 34°.25 C.; 72 minutes after death, 31°.8 C.; temperature of atmosphere, 17° C.

The blood in the cavities of the heart, and in all the organs and tissues, presented a brownish yellow color.

Experiment 236: Illustrating action of Per-Oxide and Bin-Oxide of Nitrogen.

1860. Strong, active Pigeon; head of bird introduced into a receiver containing chiefly Per-Oxide of Nitrogen.

The effects were almost instantaneous, and death took place in 28 seconds. There appeared to be no special increase in the action of the heart, which continued for a few seconds after the cessation of respiration. Temperature of rectum before the action of the Per-Oxide of Nitrogen, 41°.7 C.; the temperature rose slightly during the action of the gas, and at the time of death stood at 42°.05.; temperature of rectum 55 minutes after death, 35°.75 C.; 84 minutes after death, 33°.75 C.; temperature of atmosphere 17° C. The blood in all parts of the body presented the peculiar brown, and brownish yellow, and purplish color, as in preceding experiments.

Experiment 237: Illustrating action of Deutoxide and Per-Oxide of Nitrogen on Dog.

1860. Stout, active, healthy, cur bitch; head surrounded by a receiver, fitting closely around the neck, and through the opening at the other extremity the gases were introduced.

The gases appeared to produce at first a stimulant effect upon the nervous system, and an irritant effect upon the mucous membrane of mouth, eyes and nose, and bronchial tubes. The struggles were at first very violent; in a few moments, white froth issued from the mouth. In the course of 10 minutes, the breathing became laborious, the struggles ceased, and the dog died, 20 minutes after the commencement of the experiment. Temperature of rectum of dog, 39°.8 C.; the temperature commenced to descend immediately after death, and in one hour stood at 37°.5 C.; in two and one-half hours, 35°.5 C.; in 5 hours after death 31°,5 C.; temperature of atmosphere 17°.5 C.

Autopsy 22 hours after death.—Blood-vessels of brain, spinal cord, and of all the organs and tissues filled with brownish yellow and purplish blood. Lungs presented a brown, mottled color; bronchial tubes filled with frothy mucus. Muscles of the heart of a pale brown color. lungs and all the organs of a brownish color. The liver resembled the bronzed liver of Malarial Fever.

The blood was drawn half an hour after death. It was fluid—presented a dark brown color, and coagulated immediately after leaving the body; coagulum firm; serum clear. Under the microscope, the blood corpuscles presented a swollen, almost perfectly round shape.

Exposure to the atmosphere did not induce any special alteration in the brown and yellow color of the blood. It was possible to distinguish at a glance, the blood of animals thus destroyed from that of those which had been killed by mechanical means, or by Carbonic Oxide Gas, or by Carbonic Acid Gas. When the blood was painted on stiff, white paper, it retained its color, and at the end of 14 years it can still be distinguished from any other dried blood.

Experiments 238, 239, 240, 241, 242: Illustrating the action of Dentoxide and Per-Oxide of Nitrogen.

The blood of five cats was carefully examined under the microscope, and the appearances noted.

These animals were then successively subjected to atmospheres of these gases, in large glass receivers.

In each case the animals struggled violently, and cried, the cries expressing great agony and pain. Before death, they became comatose, the respiration spasmodic, and the mouth was filled with froth. The time of death varied from 2 to 10 minutes.

Blood drawn, both during life and after death, presented a dark brown appearance, wholly unlike healthy blood; and the blood corpuscles presented a swollen, altered appearance. All the organs, as well as the muscular tissues, presented the usual brownish appearance.

Experiments 243, 244, 245, 246, 247, 248, 249, 250: Repetitions of preceding Experiments on Various Animals, illustrating the effects of Bin-Oxide and Per-Oxide of Nitrogen.

Results similar to those just recorded. In all cases, no matter what the character of the animal, profound changes were induced in the color of the blood and organs, and this color was similar in all the various classes of animals.

EXPERIMENTS ON THE INHALATION OF CHLORINE.

Experiment 251: Effects of Chlorine on Birds.

January, 1861. Large, active Pigeon. Head of bird held in mouth of glass receiver containing Chlorine. The effects of the Chlorine gas were immediate, after the first inspirations. The bird struggled violently. The action of the heart was greatly increased. The effects on the temperature were marked and decided. Temperature of atmosphere 16°.5 C.; temperature of rectum of bird before the inhalation of the gas, 41°.9 C. The inhalation of the Chlorine produced a rapid rise in the thermometer, and in 5 minutes stood at 42°.5 C. During this rise in the thermometer, the action of the heart was greatly increased in number and force. The thermometer was elevated and violently agitated at each impulse of the heart. The head of the bird was held in the gas only a few seconds, just long enough to cause several inspirations, and was then removed, and as we have said, in five minutes it had the effect of causing an elevation of 0°.6 C. The temperature then commenced to descend, and at the end of two minutes stood at the original point, viz: 41°.9 C. The bird was again subjected to the action of the Chlorine gas, and the action of the heart, which had subsided with the fall of the temperature, immediately became violent, and the thermometer indicated a rise of temperature, and in two minutes stood at 42°.2 C. At the end of this time, which was just 9 minutes from the first action of the gas, the bird gave a violent struggle and died. As soon as death took place, the thermometer, after remaining stationary for a few minutes, commenced to descend, and in 50 minutes stood at 36° C.

This experiment confirmed the result previously stated, that Chlorine acts as a stimulant to the heart, and also increases the animal temperature.

Autopsy, one hour after death.—The interrupted electrical current had no effect on the voluntary and involuntary muscles. The blood was fluid, and presented a purplish brown color, but changed to the arterial hue when exposed to the atmosphere. Cerebro-spinal system not specially congested. Cavities of heart filled with fluid blood, which did not coagulate when removed. Lungs presented a pale color, quite different from the brilliant hue of the lungs of birds. Hæmorrhage had taken place from the mucous membrane of the mouth and trachea. Liver congested. Under the microscope, the blood corpuscles in many instances presented an altered, swollen and shrivelled appearance.

Experiments 252, 253, 254, 255, 256, 257, 258, 259, 260:

Repetitions of preceding experiments with Chlorine on birds. Results similar to those detailed in Experiment 251.

Experiment 261: *Illustrating the effects of Chlorine Gas on Dogs.*—May 27th, 1861. Young, but grown hound dog. Action of heart, 100 per minute; respiration 50 per minute; temperature of atmosphere, 25° C.; of rectum, 39°.7.

The first inhalations of the Chlorine, mixed with four times its volume of atmospheric air, produced violent struggles and cries, and the thermometer rose almost immediately to 39°.9 C. Action of the heart 2 minutes after the inhalation, 113. The Chlorine excited the salivary glands and mucous membrane of the mouth violently, and the saliva poured in streams from the mouth. This effect is characteristic of Chlorine, which acts powerfully upon the mucous membrane. Ten minutes after the first inhalation, the Chlorine was again administered, and again excited violent struggles, and the force of the impulses of the heart was still further increased. Action of the heart 114 per minute. As in the case of the action of Bromine, so also in that of Chlorine, the pulsations of the heart were greatly accelerated in inspiration, but were diminished in expiration. The respiration was diminished in frequency, and in 30

r the inhalation of the Chlorine, it was only 18 per minute. The respiration was,
ller and more labored than before the administration of Chlorine.

rine was again administered by inhalation, 35 minutes after the first inhalation.
ıd loud cries were again excited. These struggles appeared to be due to the irri-
s of the Chlorine upon the fauces, and bronchial tube, and nose, and to spasm of
is, and the consequent sense of suffocation.

inhalation, the action of the heart was 114, and respiration 16 per minute; tem-
rectum, 39°.9 C.

inutes after the preceding observation, during which time no Chlorine had been
l, the action of the heart was 116, and the respiration 24; temperature of rectum,

vas now removed from the operating table; he stood up and walked with facility,
l to be oppressed in his breathing; the sounds of the lungs indicated an accumu-
ıcus in the air cells of the bronchial tubes, and he gave repeatedly short, hoarse
ıe salivary glands and mucous membrane of the mouth and nostrils of this dog,
cited to a most profuse secretion, and at least one pint of mucus had been poured

after the preceding observation, the dog still coughs occasionally, and walks
excessive secretion of mucus has ceased. Action of heart, 140; respiration, 22;
of rectum, 39°.7 C.

morning the dog is active, but suffers with a slight cough, and mucus ralis in
Action of heart, 120; respiration 32; temperature of rectum, 40°.9 C. Under
of the Chlorine, inducing irritation and congestion of the lungs, the temperature
ours, risen 1° C.

ur hours after the inhalation of the Chlorine, one fluidounce of a saturated
Chlorine in water, was injected into the left jugular vein. The dog remained
ew seconds, then cried out in great distress, the respiration ceased, but the heart
act slowly. One minute after the injection of the Chlorinated water, and the
respiration, the heart still pulsates. The temperature commenced slowly to
soon as the effects of the Chlorine, in reducing the respiration were manifest, and
tes after the injection, stands at 40°.5 C. A most copious flow of urine has taken
nutes after the injection of the Chlorine, all signs of life are extinct.

x was next opened, and artificial respiration instituted—the heart had ceased to
auricles, especially the right auricle, responded to the artificial respiration, and
to beat slowly. The ventricles could not be excited to contract, either by me-
nuli, or by strong interrupted electrical currents. All the muscles of voluntary
onded to the electrical stimulus. The peristaltic motions of the intestines could
ted.

tions of the auricles continued for 20 minutes after the institution of artificial
after their cessation, the auricles were opened, and it was found that the blood
ted in the auricles, and in the right ventricle. This fact is interesting, as show-
lity with which the blood will coagulate under the action of certain poisons.
heart distended with black, coagulated blood. Liver of a deep purplish, slate
hat of Malarial Fever. 45 minutes after death, the muscles responded feebly to
ted electrical current. The blood from all parts presented a brownish and
pearance; the muscles also presented a brownish, bleached appearance. Rigor-
hours after death, well formed.

262: *Action of Chlorine on Warm-blooded Animals.*—January, 1861: Fine, large
n a receiver, into which Chlorine was slowly introduced. The struggles of the
ame very violent, and the actions of the lungs spasmodic. Froth issued from the
e period of excitement lasted 10 minutes, and was followed by a comatose condi-
panied with spasmodic actions of the respiratory and voluntary muscles generally.
tremors of all the muscles. Death took place in 20 minutes.

ne hour after death.—Blood-vessels of the brain filled with dark purplish, brown
muscles presented a more dull, brownish, bleached color than usual, and pre-
rked contrast to the deep colored muscles of animals killed by mechanical means.
ng for more than one hour, the blood did not coagulate. The lungs presented a
leached appearance. The bronchial tubes did not present any appearance of
gestion. All the vessels supplying the bronchial tubes, and trachea, and air cells
with brown, fluid blood.

avities of the heart contained fluid blood. Under the microscope, some of the
d corpuscles presented an altered, swollen appearance; others were normal.

s 263, 264, 265, 266, 267, 268, 269, 270, 271: Repetitions of preceding experi-
rm-blooded animals—mammalia; results similar.

272: *Effects of Chlorine Gas on Dog.*—May 8th, 1860: Healthy, young dog. Tem-
atmosphere, 26° C.; of rectum, 40°.75 C. The dog was introduced into a large

glass receiver, and subjected to the action of Chlorine gas; the dog struggled violently, and cried greatly during the action of the Chlorine. During these struggles, and during the action of the gas, the thermometer rose, and at the end of 5 minutes, stood at 41°.6 C.

Death took place in 7 minutes. During the action of the gas, the tongue became very red, and the breathing was spasmodic. 16 minutes after death, the thermometer indicated 41° C.; 128 minutes, 37°.9 C.; 143 minutes, 37°.5 C.

Autopsy, 143 *minutes after death*—Cadaveric rigidity well marked. Powerful interrupted magneto-electric currents passed in every direction through the nerves of motion and sensation, and through the nervous centres and muscles, produced no effects upon the muscular system. Blood-vessels of brain filled with dark, brownish colored blood. Lungs much congested; liver also congested in various portions. Under the microscope, the blood corpuscles were in many cases swollen, and in others crenated: they were especially altered in the blood-vessels of the lungs.

Experiment 273: *Injection of Atmospheric Air into the Blood.*—1860: About one half pint of atmospheric air was forcibly and rapidly forced into the left jugular vein of an active Scotch Terrier dog. The animal emitted piercing cries, struggled violently, andd ied in less than one minute from the commencement of the experiment. When the pipe was withdrawn, air and blood issued with force from the vein. Temperature of atmosphere, 15° C.; of rectum, 39.°5. The temperature remained stationary during the injection of the air, and commenced to fall immediately after the death of the dog, and one hour after, was 37°.1 C.; 95 minutes, 36°.26 C.; 5 hours and 45 minutes after death, 28°.8 C. Rigor-mortis commenced one hour and thirty-five minutes after death. 22 hours after death, temperature of rectum, 17°.1 C.; temperature of atmosphere, 14°.4 C.

Autopsy, 22 *hours after death.*—Blood-vessels of the brain and spinal cord greatly congested with blood, which contained numerous air bubbles. Lungs much congested with blood, and blood-vessels contained air. Heart contained air in all the cavities. The liver was congested and mottled, and the hepatic and portal blood-vessels contained numerous air bubbles. The stomach and intestines, both upon the exterior and interior, presented a deep red, congested appearance. The large and small bood-vessels and capillaries could be seen ramifying in every direction, as if fully injected with red coloring matter. The blood was fluid in all the vessels, and did not coagulate when removed from the body. When first removed from the vessels, and whilst in the vessels, it presented the usual venous hue; but after removal and exposure to the atmosphere, it rapidly absorbed oxygen, and changed to a scarlet arterial hue. Microscopical examination revealed no alterations in the form of the colored corpuscles.

During the course of 48 hours, the coloring matters of the blood exuded through the coats of the blood-vessels of the stomach and intestines, and colored the tissues of a uniform deep arterial hue. To the eye, both the external and internal surfaces of the stomach and intestines presented the appearance of the greatest congestion and marked inflammation.

In this experiment, a purely mechanical cause produced intense congestion of the blood-vessels, and especially of the smaller branches and capillaries; and on standing, the textures were uniformly discolored by the escape of the coloring matters of the blood. Similar phenomena are witnessed in the bodies of patients who have died with various diseases, and under the action of such poisons as Prussic Acid and Cyanide of Potasium, which induce congestion of the internal organs. It is also evident that the appearances of congestion are greatly increased by post-mortem changes. Such facts illustrate, in the clearest manner, the necessity of caution, when we endeavor to determine accurately the characteristic morbific effects of diseases and poisons.

Experiments 274, 275, 276, 277, 278, 279, 280: Illustrating the effects pf the mechanical injection of air into the blood-vessels; results similar, as in Experiment 273. The appearances of congestion of the various organs and tissues varied, in these experiments, with the amount of air injected, and the force used.

Experiment 281: *Illustrating the effects of the Continuous Inhalation of Hydrogen Gas.*—Maybank, Colonel's Island, Liberty County, Georgia, 1855: A yellow-bellied terrapin, which had been placed in a receiver of Hydrogen gas, died in 10 hours. The blood corpuscles from all parts of the body presented an altered, shrivelled appearance, similar in all respects to that produced by Carbonic Acid gas. The simple exclusion of the atmosphere, and the substitution of an inert harmless gas, produced remarkable alterations in the shape of the blood corpuscles. The urine of this chelonian contained grape sugar.

Experiment 282: *Effects of Exclusion of Air on the Blood.*—Maybank, Liberty County, Ga. July, 1855: Ligatures were passed around the trachea of yellow-bellied terrapins, (*Emys Serrata*), and salt water terrapins, (*Emys Terrapin*). The access of air to the lungs was thus completely cut off. These chelonians gave signs of muscular contractility from 12 to [illegible] hours.

In all cases, after death, the blood presented a dark purplish, almost black color, and was than that of reptiles in its normal condition. The blood coagulated when

corpuscles, (under the microscope), had undergone important modifications·
n were shrunken, contorted and contracted ; others were swollen, assuming the
roids, cubes and ovoids. The nuclei, which were rendered distinct by the action
d, in many cases presented corresponding changes.
f oxygen passed through the blood did not alter its color, and did not restore
blood corpuscles to their normal shape. In every instance, the urine of these
ntained grape sugar.
283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294: Illustrating the effects
as and Atmospheric Air on animals in closed receivers.
performed a number of experiments on various animals, both warm and cold-
cing them in confined portions of Nitrogen and atmospheric air, in closed

rrangement was made by which the Carbonic Acid Gas, Ammonia and organic
wn off from the lungs, were absorbed, as fast as generated, the animals lived at
es as long as when they were subjected to the deleterious effects of the products
. The truth of this proposition was readily demonstrated, thus : Two birds, of
d age and activity, are placed in two glass receivers (filled with either Nitrogen
ic air), of precisely the same capacity. Hermetically seal up one of the birds in
Invert the other receiver over the water bath, so that the feet of the bird shall
ater. In the latter experiment the water will absorb the Carbonic Acid Gas and
ious products from the lungs, skin, kidneys and bowels.
ermetically sealed, will manifest signs of poisoning in a few minutes, and will
ulsions in less than one hour. The bird confined in precisely the same amount
ic air or Nitrogen, in the receiver inverted over water, will show no signs what-
ngement at the time of the death of the other bird, and will live for many hours.
hree-fourths grown, cock,) thus treated, during the winter season, lived for more
rs in a receiver containing less than one gallon of atmospheric air.
h in all such cases, the blood presented a black, fluid appearance, and under the
the blood corpuscles frequently presented a crenated appearance.

ts of the preceding experiments sustain the view which I have advanced,
n at least of the phenomena of Cerebro-Spinal Meningitis are due to the
of respiration ; which disturbances result from derangement of the nerves
entres at the base of the brain, and are attended by the retention of a dele-
(Carbonic Acid Gas), and other poisonous matters in the blood.
inflation of the pulmonary apparatus with air does not constitute *respira-*
is process there are changes involved, which are dependent on nervous
and as the integrity of the blood depends absolutely upon the proper per-
f the respiratory act, in all its manifold physical, chemical and physio-
ions, it is evident that when the nerve centres and nerves which control the
act, are suddenly and powerfully impressed by an inflammatory action, cer-
of the blood must follow, in the relation of effects to a definite cause.
lts of the foregoing experiments clearly show that it is useless to attempt to
haracter of a disease, by a few crude observations on the blood found in the
death.
ous phenomena manifested during the progress of Cerebro-Spinal Meningitis,
e constitution and appearance of the blood, and the results of post-mortem
s, do not sustain the proposition that the disease is essentially a blood

icult to find any poison which acts exclusively upon the blood, and in
to select the best examples of diseases, produced by poisons, which are
t directly upon the blood, it must also be admitted that there is a class of
which may with much plausibility be referred to the simultaneous or con-
ion of the poisonous agent or agents upon the sympathetic and Cerebro-
ous systems.
oses of comparison, I have made selections from my experiments and original
and investigations, upon the action of three distinct poisons, which are
oduce the most powerful effects upon the constitution of the blood, viz :
the Poison of the American Copperhead and Rattlesnake, and Putrid
atter.

Experiment 295; *Illustrating the action of Bromine.* Augusta, Ga., February 4th, Active Female Scotch Terrier. Action of heart, 96 per minute; action of heart increased during inspiration, and diminished during expiration. It was most rapid at the point of complete inspiration, and slowest at the end of expiration. Respiration 10 per minute; temperature of atmosphere, 11°.1 C., of rectum of bitch, 39°.05 C.

The dog was made to inhale the fumes of Bromine. The effects upon the animal were immediate, irritating the lungs, eyes, and mouth, causing labored respiration, and most violent struggles, and loud cries. A profuse secretion of mucus took place from the eyes, mouth, nose, and bronchial tubes. The dog struggled violently, and the temperature rose 0°.30 C. in 5 minutes, and stood at 39°.35 C.

15 minutes after the commencement of the inhalation of the fumes of Bromine, largely mixed with atmospheric air, the heart gave 90 impulses per minute, and the respiration was [illegible] temperature of rectum, 39°35 C.

30 minutes after the commencement of the inhalation of Bromine, the respiration is full and regular, but the action of the heart can scarcely be felt, and the temperature of the rectum is slowly descending. The bronchial tubes and rectum, appear to be fast filling with mucus, and loud rales may be heard, at a considerable distance, and the bronchial tubes apparently contracted, the phenomena and sound resembling those of Asthma in the human subject.

40 minutes after the first inhalation of the Bromine, the temperature of the rectum was 39° C., showing a loss of 0.35 C. in 40 minutes. The temperature continued to descend for several minutes, and after reaching 38°.9 C., it slowly rose during several minutes to 39° C., and then again in 10 minutes fell again to 38°.9 C. The filling of the bronchial tubes with froth, and the diminution of the action of the heart, are without doubt important causes of the fall in the temperature. The action of the heart is now so feeble that it is with difficulty counted.

The dog was now loosed, one hour after the commencement of the inhalation—it was able to walk about with perfect ease, and appeared to retain all its senses, with the exception of sight, which was impaired by the local action of the Bromine upon the cornea, rendering it opaque. The skin of the face appeared to be greatly irritated by the Bromine as well as the mucous membrane of the mouth and nose. The temperature of the body continued steadily to descend, and the difficulty of breathing continued steadily to increase; and at the end of five and one quarter hours, the respiration was labored and full, with loud rattling sounds in the throat, and wheezing sounds in the lungs; bloody froth issued from the mouth and nostrils; there was a great tendency to sleep; when aroused by shaking and loud talking, attempted to walk, but was unable to do so, the limbs being weak and tremulous, [illegible] fore legs) for a few moments, and then fell over on the side, and appeared to be completely exhausted, and almost immediately relapsed into a profound slumber, with loud, hard labored breathing.

Action of heart feeble, determined with difficulty, 100 per minute. Respiration, 15 per minute; temperature of rectum, 34°.35 C. The temperature of the body has fallen 5° C. since the administration of the Bromine. Half an hour after this observation, the temperature of the rectum was 33°.7 C., having fallen 0°.65 C. in this time. The extremities and surface of the body also feel very cold. The loss of temperature appears to be due to three causes; 1st, the local inflammation of the pulmonary apparatus, and the filling of the bronchial tubes and air cells, with thick tenacious mucus; 2d, alteration of the blood; depressing effects upon the action of the heart.

At each inspiration there is a spasmodic contraction of the muscles of the neck, associated in the act of inspiration. The contractions of the muscles of the mouth and nose, as well as the spasmodic action of the organs of respiration, indicate derangements in the respiratory centres of the medulla oblongata, and evidence approaching dissolution.

The temperature continued to fall. The dog was kept under observation for about 7 hours, till 6 P. M.

During the remainder of the evening and night, the phenomena were not observed;—the dog was found dead the next morning. Rigor-mortis complete. The temperature of the body corresponded with that of surrounding inanimate objects, and the atmosphere. It is probable that the dog died shortly after the last recorded observation.

Autopsy, about 12 hours after death.—Brain greatly congested, with dark, almost black blood; both arteries and veins appeared to be filled with blood, even the minutest vessels were distended with blood. The blood-vessels of all the membranes of the brain, were thus filled with blood. The muscles presented a dark purplish hue, and when cut, little or no blood escaped from them. The coloring matter of the blood appeared to have transuded through the minute blood-vessels. The blood in the small vessels of the dura-mater, arachnoid and pia-mater, after exposure to the atmosphere, changed to a bright arterial hue. Microscopic examination of the brain and spinal cord, revealed no lesions in the ultimate elements.

The lungs collapsed but slightly, when exposed by the removal of the anterior walls of thorax. They presented a highly congested appearance throughout. Mucus membrane of bronchial tube of a deep red color, and greatly congested with blood. Bronchial tubes and air cells contained much bloody froth.

All the cavities of the heart were distended with imperfectly coagulated, viscid, black, tar-like blood.

The Vena Cava, and large veins of the abdomen, stomach and intestines, were distended with black, viscid, tar-like blood. Liver congested in some parts and not in others, presenting a mottled appearance; gall-bladder filled with bile. The mucous membrane of the stomach was of a uniform, deep reddish purple color, and appeared to be in a state of active congestion. No blood was effused into the stomach. Mucous membrane of intestines purple, greatly congested; blood vessels distended with blood. The mucous membrane was coated with thick bloody mucus, and when this was washed away, the surface presented a deep purple color. It is possible that portions of the bromine may have been swallowed with the saliva and thus acted locally; it is also probable that the congestion of the alimentary canal was due to the alterations induced in the constitution of the blood itself.

When the effused blood was examined under the microscope, it was found to consist of altered blood corpuscles, resembling the coffee ground deposit of yellow fever black vomit, together with less altered blood corpuscles, and acicular crystals, similar to those found in such abundance in the blood.

Spleen presented a dark blue color, and appeared to be more distended with blood, and softer than usual. The blood of the spleen contained acicular crystals of hæmatin. Kidneys congested with black blood.

The blood after its removal from the vessels coagulated imperfectly, and there was no contraction of the coagulum; it had no consistency and the coagulum was ruptured with gently shaking the vessel, and not a drop of serum was separated. Upon exposure to the atmosphere the blood changed to a brilliant carmine hue, when spread in thin layers; but in mass it presented a black color, resembling tar in color and tenacity, and did not change to the arterial hue even after 48 hours.

Under the microscope the colored blood corpuscles were swollen, and had a tendency to run together, and form stars and acicular crystals. The blood contained numerous acicular crystals of hæmatin. These crystals increased in number and size, during the slow drying of the blood upon the glass slide. The crystals in the blood in its natural state, when first abstracted from the vessels were acicular and colorless. The crystals of hæmatin which separated in great numbers during the drying of the blood presented a deep brown red color.

Careful drawings of the appearances of the blood and of the organs specially affected, as the lungs and intestines were made in this case, as they had been in the previous experiments for comparison.

It is worthy of note that the Bromine had acted powerfully upon the blood, causing alteration in the form of the colored blood corpuscles, and the formation of acicular crystals; which differed materially from the crystals of hæmatin, which separated in great numbers, during the slow desication of the blood.

It is also worthy of note that these alterations of the blood, were attended by passive hæmorrhages from the intestinal mucous membrane, as in yellow fever.

EXPERIMENTS ON THE ACTION OF THE POISON OF CERTAIN AMERICAN OPHIDIANS.

Experiments with the Poison of the American Copperhead (Trigonocephalus Contortrix—Holbrook).

This reptile was first described by Linnæus, in the twelfth edition of his Systema Naturæ, under the name of Boa Contortrix. The genus Boa, of Linnæus, included all those serpents, venomous or not, that had plates under the tail, as well as on the abdomen.

Synonymes.—Boa Contortrix, Lin., Syst. Nat., vol. 1, p. 373. Angkistrodon Mokeson, Beauv., Tran. Amer. Phil. Soc., vol. IV., p. 381. Cenchris Mokeson, Daud., Hist. Nat. des Rept., vol. V. p. 358, pl. XI., fig. 3. Scytalus Cupreus, Rafin., Am. Jour. Arts & Sci., vol. I., p. 85. Scytalus Cupreus, Harl., Med. & Phys. Res., p. 130. Ceuchris Mokeson, Harl., Med. & Phys. Res., p. 128. Trigonocephalus Contortrix, Holbrook, North Am. Herp., 1838, vol. III., p. 39, pl. XIV. Trigonocephalus Contortrix, DeKay, Zoology of New York, Part III., p. 53 pl. IX., fig. 18. Copperhead, Vulgo, Red Adder, Dumb Rattlesnake, Red Viper, Chunckhead, Copper-belly, Dead Adder, Bastard Rattlesnake.

The geographical distribution of the Trigonocephalus is extended, Naturalists having observed it upon the eastern Atlantic slope, from the western parts of New England to the middle of Florida. Its geographical range extends from about 45° north latitude to the Gulf of Mexico, whilst upon the west it appears to be limited by the Alleghany Mountains. In the

Valley of the Mississippi, its place is supposed, by Dr Holbrook, to be supplied by the [illegible] phis Atro fuscus, of Troost, which it resembles in habits. The motions of the [illegible] are sluggish; and when approached it prepares for defence, raising its head, throwing [illegible] tongue, hissing and contorting, and flattening the head and body. The following is [illegible] rate description of this reptile, as given by Dr. Holbrook in his great work on North [illegible] Herpetology:

Characters.—Head very large, triangular, covered with plates in front and on the [illegible] with scales behind, and a pit between the eye and nostril; upper jaw with poisonous [illegible] body, thick, light hazel-nut brown, with transverse bars of dark brown, narrowest [illegible] mesial line, broader and bifurcating on the flanks; tip of the tail coriaceous.—*Pl.* [illegible] *fol.* 42, *sc.* 4.

Description.—The head is very large, triangular, and broadest posteriorly; the mouth [illegible] with the upper jaw strong, and furnished with poisonous fangs; the vertical plate is [illegible] larly pentagonal, with an acute angle directed backwards; the superior orbital plates [illegible] Irregularly triangular, with their apices turned inwards, and their bases outwards, [illegible] over the eye; the occipital are rhomboidal, the frontal plates are large and [illegible] the anterior frontal are of the same form, but smaller; the orbital is large, [illegible] its bases downwards and its apex upwards, and truncated. There are two nasal [illegible] anterior quadrilateral, with its posterior margin hollowed; the posterior trapezoid, [illegible] anterior border lunated to complete the nostril. There are three posterior orbital [illegible] nearly of the same size, the upper one triangular; the inferior orbital plate is single, [illegible] narrow, and semi-circular. There are two anterior orbitals, the upper quadrilateral; [illegible] lower makes the superior wall of the pit between the eye and the nostril, which is [illegible] below by the second labial plate, and by a small plate that rests on the third labial. [illegible] margin of the upper jaw is covered by semi-quadrilateral plates. The nostrils are large, [illegible] ral, and placed near the snout; the eyes are large, but do not at first appear so, from the [illegible] jection of the superior orbital plates; the pupil is elliptical, vertical and dark; the iris is [illegible] golden with a tinge of red. The neck is greatly contracted; the body is elongated, [illegible] to near the tail, and is covered above with rhomboidal scales, carinated, except those of [illegible] lower rows, which are smooth and larger. The abdomen is covered with plates, the last [illegible] of which is very large; the tail is short, thick, conical, and ends in a horny tip.

Color.—The head is a delicate light hazel-nut brown above, with the labial plates [illegible] the ground of the *color* of the whole animal, body and tail, is of the same delicate hue, [illegible] on the sides, where the scales are beautifully freckled with small dark spots. Behind [illegible] occiput begins a series of transverse bars of dark brown, continued to near the [illegible] the tail. These bars are contracted along the vertebral line, but are broader and [illegible] on the flanks. These bars are lightest on the back; darker at the sides, with their [illegible] and posterior margins bordered with brown. The under surface of the whole animal is [illegible] colored, freckled with minute points of dark brown; and a series of dark-colored spots [illegible] abdominal plates, near their extremities, which then ascend, to include a scale or two [illegible] flanks, and are so disposed that one spot corresponds to the point of bifurcation of the [illegible] verse dorsal bars, and another to the space between them. All these spots terminate [illegible] tail, which is flesh-colored below.

Dimensions.—Length of head, 1 inch 2 lines; breadth of head, 11 lines; length of [illegible] inches; length of tail, 3½ inches; greatest circumference of body, 3¼ inches; [illegible] of neck, 1 inch 10 lines. In the individual described there were 150 abdominal [illegible] sub-caudal, and four pairs of bifid plates, or scales, near the apex.—[*North American* [illegible] *tology*, *Phila.*, 1838, *Vol. III.*, *pp.* 39–41.]

As a general rule, the Trigonocephalus Contortrix inhabits dark, damp, shady [illegible] though it is frequently found in meadows bordering upon the low lands. The [illegible] which were used in the following experiments, were captured under the steps of a small [illegible] house, situated upon a slight elevation in the neighborhood of an extensive marsh. [illegible] related species, the Water Moccasin (Trigonocephalus Piscivorus), which is very [illegible] in the low swampy regions of Georgia and Carolina, frequents the rice dams and [illegible] is never seen far from water; and in summer numbers of these reptiles may be seen [illegible] in the low branches of such trees as overhang the water. The reptile is exceedingly [illegible] ous to the unwary; and is the especial terror of the negroes about the rice plantations, [illegible] is very sluggish in its movements, taking no pains to avoid the descending foot of the [illegible] but attacks every thing that comes within its reach. From its habit of erecting its [illegible] opening the mouth for some seconds before striking, and from the white appearance [illegible] mouth, it has been called, on the rice plantations, the cotton mouthed moccasin. I [illegible] stout negro man who had been bitten by a large water moccasin. The symptoms of [illegible] were very marked. For hours the man appeared to be in extremis, notwithstanding [illegible] scarification of the wound and the administration of large quantities of alcoholic [illegible] Beneficial results appeared to be derived by applying, chickens and frogs cut [illegible] the wound. The entire leg and thigh swelled enormously, and the recovery was [illegible]

The limb continued somewhat larger than the sound leg for several years, and the man complained of pain in the region of the site of the poisoned wound during certain changes of the weather, and especially during damp spells. Both species of the Trigonocephalus feed upon frogs, mice, birds and insects. As far as my information extends, they do not, as the king snake, feed upon other reptiles of the same genus and species. The copperhead is regarded by the negroes with as much dread as the rattlesnake. It is, however, not so abundant in the lower portions of Carolina and Georgia as the water moccasin and the rattlesnake; and instances of persons bitten by it are comparatively rare. DeKay, in his Zoology of New York, says that the poison of the copperhead "is considered as deadly as that of the rattlesnake; and an instance is recorded, where a horse, struck by one of these reptiles, died in a few hours."—[Part III., p. 54.]

EXPERIMENTS ON BITE OF COPPERHEAD, (TRIGONOCEPHALUS CONTORTRIX.)

Experiment No. 296.—Augusta, Georgia, May 12th, 1862. Subject of experiment, a fine large black cur dog, half Hound and Pointer, (male). Temperature of rectum of dog, 103°.1 F. temperature of room in which the experiment was conducted, 100°.4 F.; respiration of dog panting, irregular, from the heat of the weather; impulse of heart, irregular, about 90 per minute. 1½ o'clock P. M. Immediately after determining the temperature, the dog was brought near the copperhead, which struck him twice on the foot of the right hind leg. The moment that the fang entered, the dog emitted piercing cries, and appeared to be greatly agitated, and the foot began to swell almost immediately.

The thermometer introduced into the rectum, stood at 104°.2′ F., and remained thus for ten or fifteen minutes, and then slowly descended 0.2°, and remained stationary at 104° F. This would indicate that the first rise was due partly to the agitation and struggles of the animal, excited by the pain of the bite of the snake. Twenty-five minutes after the stroke of the snake, temperature of rectum 104° F.; heart as yet not specially affected, although the foot is greatly swollen; thirty minutes after stroke of snake, (5 minutes after last observation) action of heart 98 per minute, and somewhat irregular as before the experiment, being affected by inspiration and expiration; fifty minutes after stroke of snake, (10 minutes after last observation,) action of heart 110 per minute. One hour after the bite of the snake, temperature of rectum still 104° F., the action of the heart appears to be diminished in force and increased in frequency, being 124 per minute. The swelling is gradually proceeding up the thigh, the limbs being greatly distended up to the knee-joint, and the lower portion of the thigh is commencing to swell. *A bloody serous fluid now issues from the wound in considerable quantities, and the epidermis can be readily removed from all the region around the point where the fang entered, presenting a red, raw appearance. The swollen parts feel hot, and are several degrees warmer than the sound leg.* The dog is perfectly quiet, and, in fact, appeared to become so as soon as the swelling commenced.

Two hours after the stroke of the snake, action of heart 156 per minute; respiration not increased. Swelling of leg greatly increased, and extending up and involving the thigh: the swelling increases in a decided manner, with defined borders. Blood and bloody serous fluid continue to issue from the points at which the fangs entered: *under the microscope the blood-corpuscles of this fluid present a swollen, altered appearance.* The dog does not whine or cry, but appears restless and sometimes groans, and pressure on the swollen leg appears to excite some pain, as manifested by his whines. The temperature of the rectum still remains at 104°F. When the dog is loosed, he runs about, with considerable life, on three legs, and during this exertion there is a slight rise of temperature in the rectum, of *one-tenth* of a degree F. Action of heart 150 per minute.

During the night the dog remained quiet, and next morning appeared much better. Swelling in leg declining. Temperature of rectum next day, at 11 o'clock A. M., still 104° F. The animal appears to have regained his spirits. Right hind leg still greatly swollen, and several degrees warmer than its fellow. Action of heart 120, in standing posture. On the following morning May 14th, 11 A. M., dog seems lively, but the leg is still much swollen, and several degrees warmer than the sound leg; temperature of rectum 104° F. The leg is much swollen and pits when pressed; and pressure appears to cause pain; the swelling extends to the integuments of the belly and the sheath of the penis. Tongue of dog looks redder and dryer than usual. The action of the heart in the sitting posture is 120 per minute, and the force of the heart has greatly increased. The wounds and excoriated places on the foot present a much lighter color, and appear to be healing over. *May* 16th, 11 A. M.—The dog still continues to improve—swelling of leg and penis greatly reduced; temperature of rectum 103°.2 F. Dog appears to be much better; action of heart 100° in sitting posture. Muscles of limbs, as upon yesterday, tremble occasionally. This dog recovered entirely from the effects of the poison.

Experiment No. 297—Subject of experiment a fine active young cock—temperature of anus 110°.3. Augusta, Ga., May 12th, 1862, 4 o'clock P. M. The copperhead used in the preceding experiment was allowed to strike the cock upon the comb and head; the reptile appeared to be somewhat exhausted by striking the black dog in the morning. The strokes of the snake appeared to excite violent pain in the cock; he struggled violently, and opened his wings. The rapidity and force of the action of the heart were increased during the strokes of the snake, and during the struggles of the bird. During these violent struggles, and great agitation, the temperature of the rectum of the cock rose $\frac{1}{3}$° C., and then fell again to the point whence it had started, being 110°.3 F.

Fifteen minutes after the strokes, the cock breathes rapidly; the heart beats rapidly, and with considerable force. Temperature of rectum still remains at 110°.3 F. The cock was again thrown to the copperhead, and several severe blows were inflicted about the head and comb and leg, and the effects of the first strokes were thus increased.

At this time, the action of the poison resembled in some respects those of a narcotic; the cock appeared quiet and stupid, as if drunk; but when aroused, opened his eyes and looked about, and attempted to fly and run with some activity.

Thirty-five minutes after the first stroke of the snake, the temperature of the rectum still remained at 110°.3 F., whilst the head, comb, and adjoining parts, as well as the regions around the wounds in the breast, swelled greatly, and presented a dark purplish color, similar to that presented by wounds inflicted by the rattlesnake.

The effects of the poison resembled those of a narcotic—the bird remained perfectly still until aroused; it did not appear, however, to have entirely lost its reason, but was only stupid and lethargic. The cock died during the night about 9 hours after the first stroke of the snake. After death, the tissues around the wounds inflicted by the fangs of the snake were found to be infiltrated with bloody serum and tenacious blood, which did not appear to possess the power of coagulating. The muscular fibres, in the region of the wounds, which had been subjected to the direct action of the poison, were evidently in a state of softening and disorganization. The bloody fluid issuing from the various cut surfaces presented a tenacious appearance, and was of a dark purplish-brown color, and changed very slowly and imperfectly to a lighter color when exposed to the action of the atmosphere.

The coloring matter of the blood-corpuscles had evidently been altered, and had escaped in many cases from the blood cells.

The infiltration of all parts around where the poison had been injected, and the flow of the blood out of the vessels which had not been ruptured by the fangs of the snake, as well as the bloody color of the effused serum—all point to profound changes both in the blood and in the capillaries and muscular tissues. A simple prick with a sharp instrument, like that of the fangs, certainly could not produce the pouring out of disorganized blood and bloody serum, through all the pectoral muscles. The blood and bloody tissues subjected to the immediate action of the poison, remained black, and did not change, even after several hours' exposure to the action of the atmosphere.

The brain was not more congested with blood than usual, and the physical and microscopical examination failed to detect any alterations characteristic of the action of the poison on the nervous structures. The spinal cord, in like manner, presented no special alterations. Heart somewhat relaxed—empty, and apparently softer than is usual with the heart of birds. The intestines, liver, stomach and spleen presented no special alterations, except that the liver appeared to be somewhat more congested with dark blood than usual. The blood-corpuscles, under the microscope, appeared in many cases to be swollen and altered in shape.

Experiment No. 298.—A portion of the dark, black and purplish-black flesh and blood, from the breast of the cock, killed by the stroke of the Copperhead, as related in the preceding experiment, was introduced beneath the skin, on the side of a young kitten, three weeks old, and secured by a bandage. Twenty-four hours afterwards, the wound looked healthy, and the kitten did not appear to be at all affected. During the night, the mother pulled off the bandage and licked out the meat and blood. No injurious effects were observed from the action of the flesh of the cock.

Experiment No. 299.—Augusta, Ga., May 12th, 1862.—The Copperhead appeared to be much exhausted by its strokes of the dog and cock, and its poison appeared to lose its activity, for a fine large pointer dog, which was bitten on the foot and lip by the snake, at the conclusion of the experiments, was but slightly affected. The temperature of the rectum, which stood before the stroke of the snake at 103°.1 F., remained at the same point, and whilst there was some swelling of the foot and lip, it was comparatively slight. The action of the poison was manifested chiefly in a tendency in the dog to sleep, and also in a slight increase in the frequency of the beats of the heart. The effects were only temporary, and the dog recovered entirely in a few days.

Experiment No. 300.—Augusta, Ga., June 5th, 1862.—The Copperhead used in the preceding experiments was allowed to rest for near one month, in order that it might accumulate a stock of poison. The fine large black cur dog, which had been employed in the first experiments, and which at this time was very fat and strong, was selected for the trial. Temperature of rectum 103°.7 F. Action of heart 100 per minute in standing posture (this number represents the impulses of the heart against the walls of the thorax).

The copperhead inflicted several severe bites upon the fore-legs and nose of the dog. In five minutes the effects were manifest. During the infliction of the wounds by the snake, the dog cried out loudly and shivered with pain. In eight minutes the nervous system had given way entirely; this loss of nervous power was ushered in by convulsive movements, the voiding of fæces, dilatation of the pupils, laborious breathing and inability to stand, complete prostration of the muscular system, frequent convulsive efforts to void fæces, and apparent loss of consciousness. The temperature of the rectum during this period of twenty-five minutes, remained at 103°.7 F., and then rose to 104° F. During the period that the thermometer remained stationary, the breathing of the dog was stertorous; as the heat rose the dog appeared better, passed a great quantity of urine, and then the breathing became better. Up to this period, after the strokes of the reptile, the action of the heart could scarcely be felt. One hour after stroke of snake, temperature of rectum 104° F. Action of heart so rapid and feeble as scarcely to be felt, and it cannot be counted with accuracy. The dog appears a little better, and notices when called. Two hours after bites of snake the action of the heart can be felt with sufficient distinctness to be counted, and is now 160 per minute in the recumbent posture: the dog has again voided a large quantity of urine, and appears sensible; the respiration, which was before 48 per minute, is now 40, and is no longer stertorous; the animal raises his head and notices when called, and the pupils are less dilated; and when raised up upon the fore-legs, maintains his position and appears quite sensible.

June 6.—Next morning, dog looks badly—*dysenteric flux from the bowels*—bloody discharges of altered blood-corpuscles, having a dingy, dark, purplish look. Temperature of rectum 101°.3 F. Extremities feel cold. Leg much swollen—the swollen leg feels warmer than the other extremities. Animal very weak and feeble. Action of heart 145; respiration 24. With the diminution in the frequency of the action of the heart, and the diminution in the frequency of the respiration, the intellect appears clearer.

The evacuations of the bowels resembled in appearance tar, presenting a black color, and consisting almost entirely of altered and partially coagulated and concreted blood.

When broken up and spread upon a glass slide, these tar-like excrements presented the appearance of a semi-transparent bloody jelly.

Under the microscope but very few blood-corpuscles could be seen, and these were altered in shape; it appeared as if the walls of the corpuscles had been dissolved, and the coloring matters had discolored the thick mucus and thick serous, and exuded glutinous and fibroid matters.

Whether the destruction of the cell-walls of the blood-corpuscles occurred in the intestines after the passage of the blood out of the blood-vessels, from ruptured vessels, or whether there were but few ruptures of the capillaries of the intestinal mucous membrane, but rather a transudation of the altered blood with its coloring matter through the walls of the capillaries, was considered important to be determined. The large quantity, and the black color of the intestinal discharges, led me to view them as of the nature of a hæmorrhage.

Six o'clock P. M.—Action of heart 145; respiration 22. Dog very lethargic and feeble in motions, but perfectly sensible. Has discharged more of the tar-like bloody matter. Temperature of rectum 101°.4 F. The dog drank a large quantity of cool water, and in a few moments the temperature fell to 100°.4 F., and remained at this point for three-quarters of an hour.

June 7, 2 o'clock P. M.—Action of the heart about the same in frequency as on yesterday, but more feeble; the dog rose up to pass excrements, and the pulsations or beats of the heart increased to 184 per minute. Respiration slow and regular as before. Temperature of rectum 103°.1 F.—there has been an increase of heat. The dog still passes from the bowels black, bloody, gelatinous, tar-like matter. The surface of the wound on the leg is of a dark color, and emits a dark colored serous fluid. The dog appears to be sensible, but is very sluggish and indisposed to motion; drinks water freely, but refuses food—has refused to eat ever since the stroke of the reptile. Lips also much swollen.

During the night this dog died.

Autopsy 30 *hours after death.*—The fore-leg which had been struck by the copperhead was infiltrated with bloody serum; all the fibrous tissues of the leg and thigh, beneath the skin, up to the abdomen and beyond, were greatly infiltrated with dark, purplish-black serum. Under the microscope this presented numerous oil-globules and altered blood corpuscles, with ragged, star-like edges; long acicular crystals were also seen floating amongst the altered blood corpuscles. The blood from the swollen, infiltrated cellular structures of the head and nose, where the snake inflicted the severest bite, presented a peculiar appearance; thousands of small acicular crystals were mingled with the altered blood corpuscles, and as the bloody serum and effused blood dried, the blood corpuscles seemed to be transformed into crystalline masses, shooting out into crystals of *hæmatin* in all directions. The blood-vessels of the brain were filled with gelatinous, coagulable blood, which presented altered blood corpuscles and acicular crystals.

The muscular system everywhere presented a dark purplish color. The heart was filled with coagulated black blood. When spread upon a glass slide, the blood corpuscles almost immediately commenced to assume a crystalline form. Blood vessels of brain filled with dark blood; membranes and structures of brain presented a normal appearance; there were no lesions of the brain recognizable to the eye. The exterior fibrous sheath of the spinal cord presented a red appearance, as if the coloring matters of the blood had been effused; structure of spinal cord natural; vertebral arteries filled with coagulated blood.

Stomach.—Mucous membrane of this viscus greatly congested—the stomach contained a considerable quantity of bloody water.

Small Intestines—Congested with blood, and presenting a dark purplish appearance. Some portions were more congested with blood than others. The congestion was especially great in the ilium, colon and rectum. The lower portions of the intestinal canal—the ilium, colon and rectum resembled raw flesh, and contained the dark, tar-like, altered blood.

The *peritoneum* presented a purplish reddish color, as if saturated with the disorganized blood. The internal coat of all the arteries was in like manner stained by the coloring matters of the blood.

The liver was congested with blood, and rapidly underwent decomposition.

Spleen somewhat enlarged.

The fibrous tissue of the lungs was infiltrated with bloody serum.

All the organs and tissues appeared to have suffered.

From the preceding experiments, designed to illustrate the mode of action of a poison about which little or nothing was known, we conclude :—

1st. The primary and chief action of the poison of the American copperhead (Trigonocephalus Contortrix) is upon the blood.

2d. The poison of the copperhead is directly destructive to the colored blood corpuscle, altering its physical and chemical properties and relations, and rendering it unfit for the performance of its important offices in circulation, respiration and nutrition.

3d. The poison of the copperhead appears to have an affinity more especially for the coloring matter of the colored blood corpuscles.

4th. Under the action of the poison of the copperhead the animal temperature is but slightly increased, notwithstanding the profound changes inaugurated in the blood; and after the establishment and propagation of these pathological changes the temperature descends.

5th. The action of the heart is increased in frequency, and diminished in force, under the influence of the poison of the Trigonocephalus Contortrix. This increase in the rapidity of the pulsations of the heart is not, as in the case of febrile diseases, attended by a marked rise of animal temperature. The difference may be due to the peculiar and direct action of the poison upon the colored blood corpuscles.

6th. In its action upon the cerebro-spinal nervous system, the poison of the Trigonocephalus Contortrix resembles a mild narcotic—whilst rendering the animal sluggish and stupid, it may produce death without the establishment of profound coma.

7th. The profound alterations induced in the constitution of the blood by the poison of the American copperhead give rise to passive hæmorrhages into the cellular structures, and from the intestinal mucous membrane. This phenomenon recalls strongly the passive hæmorrhages in certain febrile diseases, and especially of Yellow Fever. Some have supposed that the black vomit of Yellow Fever was the resultant of the effects of the preceding intense fever. Do not the present experiments indicate that it is rather the resultant of the action of a poison upon the blood and gastric-mucous membrane? We have here also an illustration of the mode in which dysentery might be produced by a poison introduced into the blood.

Experiment 301.—Augusta, Ga., June 14th, 1860; fine fat, large cur dog. Temperature of rectum 40°.2 C., temperature of atmosphere 79° F. The dog was brought near an active Rattlesnake, (Crotalus durissus) which struck him in the right foot, at twenty minutes past ten o'clock A. M.

Five minutes after the stroke of the snake, temperature of rectum 40°.2 C.; action of the heart 120 per minute; leg of dog trembles greatly, holds it up; the foot is now swelling rapidly; 15 minutes after the stroke of snake temperature of rectum 40°.24 C., there has been a slight rise of $\frac{4}{100}$° in the last 10 minutes. Action of the heart appears to be a little fuller, and is now 120 per minute. The dog was again struck by the Rattlesnake on the left foot, 30 minutes after the first stroke.

Ten minutes after the last stroke, and forty minutes after the first stroke temperature of rectum 40°.6 C; respiration rapid and panting; action of the heart appears to be rather fuller than at first. Ten minutes after this observation, (20 minutes after the second stroke, and 50 minutes after the first stroke,) the temperature of the body still continues to rise, and the thermometer in the rectum indicates 40°.8 C. The right foot and leg is now much swollen, and drops of bloody serum of a dark purplish color, issue from the wound, and the dog occasionally gives convulsive movements.

Fifteen minutes after this observation (35 minutes after the second stroke and 65 minutes after the first), temperature of rectum 41° C., temperature of surface of muscles of loins 37°.5 C. Seven minutes after this observation, and seventy-two minutes after the first stroke, temperature of rectum 40°.8 C.; temperature surface of loins 37°.5 C. Eighteen minutes after this observation and 90 minutes after first stroke, temperature of rectum 41°.23 C., temperature surface of muscles of loins 38°.20 C.

There appeared to be a great tendency to spasms of the muscles; the slightest touch, and especially the introduction of the thermometer into the anus, brought them on with great violence; whilst lashing the dog to a board the violent convulsions were excited, and the temperature of the rectum rose from 40.8 to 41°.23 C. Ten minutes after this observation, and 100 minutes after the first stroke of the Rattlesnake, temperature of rectum 41°.28 C., temperature of surface of muscles of loins 38°.6. Mucous membrane of lips and mouth injected with blood, and presenting a red appearance, much redder than normal. Pupils of eye appear to be somewhat dilated, but they contract under the influence of the stimulus of light. Respiration 140 to the minute, and panting; the rapidity of the respiration of dogs is very deceptive, for the function of the skin is so sluggish, that when excited they are compelled to make the lungs to a great extent do the office of the skin. The respiration of the dog was so rapid, that it was almost impossible to determine the action of the heart, on account of the violent and rapid action of the diaphragm.

The dog was now released from his confined position, (tied down to the board,) and as soon as his limbs were free, he moved about with ease. He was allowed to remain at liberty lying down for an hour, and then the temperature was determined. During this time he showed no signs of pain and no special drowsiness.

One hour and a half after the last observation and 190 minutes after the injection of the poison of the rattlesnake, the temperature of the rectum had returned to the normal standard. Temperature of rectum 40°.2 C., temperature of surface of muscles of loins 37°.2 C. Respiration 24 to the minute; action of heart 152 per minute. The dog had some time ago a copious evacuation of ordinary fæcal matters, and now discharges fœtid bloody watery stools. Six hours after this observation, and 9 hours and 10 minutes after the first stroke of the rattlesnake, temperature of rectum 40°.2 C.; action of heart 140 per minute; respiration gentle and natural.

June 15th, 10 o'clock A. M.—Dog appears well and hearty, with exception of swelling of legs, temperature of rectum 40°.2 C.; action of heart 120 per minute, the bloody discharges from the bowels have ceased. This dog recovered entirely.

It is important to note in this experiment, the rapid rise of temperature induced by the animal poison; and the marked effects of the poison upon the blood inducing as in the case of the copperhead, bloody discharges.

Experiment 302 : *Illustrating the action of the poison of the American Rattlesnake* (*Crotalus Durissus*).—Augusta, Ga., June 15th, 1861 : Half grown cat was struck by a medium sized Rattlesnake, which had been exhausted by striking several times before. Temperature of rectum of young cat, 38°.8 C. at the time that it was struck by the snake ; 7 minutes after, temperature 38°.2 C.; 9 minutes after the stroke, 37°.8 C.; 30 minutes after stroke, 37°.4 C.

One hour after the stroke animal apparently well, with the exception of some tremulousness of the muscles.

Temperature of the rectum 37°.8 C. During the first 30 minutes after the stroke the temperature of the rectum descended 1°.4 C.; during the next 30 minutes it rose 0°.4 C.; and continued to rise, and at the end of the next hour stood at 39° C, or 0°.2 C. higher than before the introduction of the animal poison.

The young cat recovered entirely.

Experiment 303 : *Illustrating the action of the poison of the American Rattlesnake* (*Crotalus Durissus*).—Small, active bull dog pup, 2 months old. Temperature of atmosphere, 26°.11 C.; temperature of rectum, 39° C.

A medium sized, dark-banded Rattle-snake, five feet in length, inflicted a wound with its fangs in the left side of the neck ; the fang penetrated the muscles of the neck near the spine. The bite of the reptile did not appear to excite any pain in the young dog ; he did not struggle or bark. The temperature of the rectum rose almost immediately after the injection of the poison, and in three minutes the thermometer stood at 39°.4 C. Action of heart 120 per minute. Respiration full, rather labored. The pup appeared to lose all muscular power almost immediately after the injection of the poison, and did not once struggle or attempt to rise, but lay quiet upon its side. 13 minutes after the stroke, respiration 24, action of heart 130, temperature of rectum 39°.28 C. At this time the pup lay in a profound coma. The blood appears to be settling in the capillaries of the extremities, as the feet present a purplish appearance. Respiration spasmodic. Temperature of the rectum is gradually declining, and has fallen 0°.12 C. during the last eight minutes.

Nineteen minutes after the injection of the poison coma profound; pupils greatly dilated; respiration 12 per minute and spasmodic; the muscles of the mouth act spasmodically—the mouth gasps convulsively at each inspiration. Action of heart 130. The temperature of the rectum still falls gradually, and now stands at 39° C. 22 minutes after the injection of the poison pupils greatly expanded, and do not contract when exposed to the action of the light; temperature still falling, and is now 38°.8 C. Respiration slow and spasmodic, in fact a series of spasmodic gasps separated by long intervals. 26 minutes after the injection of the poison, the respiration has ceased, action of the heart very feeble, 80 to a minute. Temperature still falling, 38°.4 C.

Twenty-eight minutes after the injection of the poison the action of the heart could not be felt; it had just ceased beating, having continued two minutes after the cessation of the respiration. From the injection of the poison to this time, the mucous membrane of the mouth and tongue did not present any special changes of color.

The temperature continued slowly to descend after the cessation of the action of the heart, and 40 minutes after the injection of the poison, and 12 minutes after the cessation of the action of the heart, the temperature of the rectum was 37°.6 C; 167 minutes after stroke of reptile (139 minutes after cessation of action of heart), 31°.8 C. In the last 127 minutes (2 hours and 7 minutes), the temperature of the body has fallen 5°.8 C.

Autopsy 167 *minutes after the injection of the poison, and* 139 *minutes after the cessation of the action of the heart.*—The interrupted magneto-electric current produced slight contractions in the muscles, showing that up to this time there had been some susceptibility to the electric stimulus.

When the skin over the region of the poisoned wound was removed, the cellular tissue was found congested with blood, and contained much dark purplish and black coagulated blood effused into the cellular tissue—the blood-vessels and capillaries of the surrounding skin were also greatly congested with blood. This effect is evidently due to the direct action of the poison upon the blood and capillaries. By the peculiar structure and arrangement of the fangs and poison bag, during the stroke a continuous stream of poison is poured into all the tissues through which it successively passes. This great pouring out of the blood all around the point at which the fang entered, was not due to the mere wounding of the vessels, for the fang could not have been much larger than a large needle, and we know that the puncture of a needle could not possibly have produced such effects in a few moments. That it is due to an immediate effect of the injected poison upon the blood-vessels, appears to be also proved by the rapidity with which the parts swell after a stroke by the fangs of the rattlesnake. I have seen the swelling commence almost immediately after the injection of the poison. The coagulated blood and effused blood was not confined to the cellular tissue, but extended down amongst the muscles of the neck as far as the fang penetrated.

Head.—The blood-vessels of the dura-mater and pia-mater were filled with dark purplish blood, which rapidly changed to the arterial hue after the removal of the skull-cap. The sinuses of the dura-mater contained well formed, dark purplish coagula; all the large veins also of the various organs contained dark purplish, coagulated blood.

Thorax.—The lungs presented a deeply congested and mottled appearance. The right auricle and ventricle of the heart were distended with dark purplish, almost black blood, and the vena-cava contained dark purplish, almost black coagula. The blood from the heart, and from all the organs, changed readily to the arterial hue upon exposure to the atmosphere.

The coagulation of the blood in the heart and vessels in such a short period after death, is interesting, as pointing to the effects of the poison directly upon the coagulating properties of the blood.

Abdomen.—Blood-vessels of the liver filled with dark blood. Stomach and intestines somewhat congested with dark blood. The mucus membrane of the intestines, and more especially of the duodenum and superior portion of the ileum, presented a highly injected, red, punctated appearance.

Under the microscope the colored blood corpuscles did not present any unusual appearance.

Experiment 304: *Illustrating the action of the Poison of the Dark Banded Rattlesnake.*—June 15th, 1860: Strong, active, well conditioned Cur Dog, Terrier blood predominating.

Temperature of atmosphere, 27° C.; temperature of rectum, 39°.2 C. The dog was thrown into the box with the snake, and several strokes were inflicted by the reptile on different parts of the legs. The struggles of the dog were very violent during the strokes of the snake, and he sprang up several times out of the deep box.

In five minutes after the dog was removed from the box, (the strokes of the snake occupied only a few moments), the dog gave signs of great uneasiness and pain.

Ten minutes after the strokes of the snake, the temperature of the rectum was 39°.8 C., showing a rise of 0°.6 C., in the short period after the introduction of the poison.

Seventeen minutes after the injection of the poison, and seven minutes after the last observation, the dog fell into a profound coma.

The temperature of the rectum rose during the struggles and excitement, during the injection, and just after the strokes; and then just before the establishment of the coma, stood still; and as soon as the coma was established, commenced slowly to descend. The action of the heart and the respiration also diminished in frequency; the action of heart 100 per minute; respiration 12 per minute. During the coma, or deep sleep, the thermometer descended 0°.2 C. The dog then revived, and immediately the temperature of the rectum commenced to rise, and 12 minutes after the commencement of the coma, (29 minutes after the bite of the snake,) the temperature of the rectum was 40°.2 C., and the temperature of the surface of the muscles of the loins, was 36°.4 C.

The temperature of the rectum continued to rise during the succeeding eleven minutes, and 40 minutes after the introduction of the poison, stood at 40°.4 showing a rise during the last eleven minutes, of 0°.2 C.; after remaining stationary for a few moments, it commenced again to descend very slowly, and in fifteen minutes, stood at 40°.34 C., showing a loss of 0°.06, in this period.

One hour and ten minutes after the first strokes of the reptile, the dog was again thrown into the box—his struggles were desperate and violent, during the renewed attacks of the snake. During the struggles of the dog, and during the infliction of the bites, the temperature of the rectum rose slowly, and in fifteen minutes, stood at 40°.5 C., showing a rise of 0°.16 C.

The dog then as before, fell into a profound sleep, and the thermometer in the rectum commenced to descend, and in 15 minutes stood at 40°.4 C., showing a loss of 0°.1 C. One hour and a half after this, the dog was again subjected to the attacks of the snake, and finding that his strokes were rather feeble, and that it was probable that he was too much exhausted to plunge his fangs to a sufficient depth beneath the skin, for the full effects of the poison, I captured the reptile, extracted his fangs, and plunged them into the muscles of the hind legs of the dog.

In these struggles with the snake, the temperature as upon the former occasions, rose and stood at 40°.6 C. As soon as the dog became quiet, the temperature of the rectum commenced to descend, and in four minutes after this observation, (10 minutes after the third attack of the snake,) stood at 40°. 4 C., having lost in four minutes 0°.2 C.; and in two minutes more descended still farther to 40°.2 C. The dog appeared sleepy and stupid. The temperature of the rectum remained stationary for a few minutes, and then commenced to rise, and in eight minutes, (120 minutes after the third attack of the serpent,) was 40°.4 C. Dog appears drowsy and indisposed to any exertion; action of heart, 150 per minute; respiration 24–26; left leg and thigh greatly swollen. Twenty-four minutes after this observation, and three hours and twenty-four minutes after the first attack of the Rattlesnake, the dog vomited a large quantity of frothy mucus, appeared to be very sick, passed a large quantity of natural urine, and then laid down with his eyes open, whining and groaning at every breath.

Two hours and six minutes after this observation, (5½ hours after the first strokes of the reptile,) lies in stupor, with eyes open, and snores as if in a deep sleep. Is very weak, and when aroused is unable to stand alone; respiration 24 per minute; action of heart so rapid and feeble that it cannot be counted. Even when the flesh is pinched and cut with a knife, the animal does not evince pain. Temperature of rectum, 40°.2 C. Sixteen minutes after this observation the thermometer in the rectum, indicated 39°.8 C., showing a fall during this period of 0°.4 C. Temperature of the surface of the muscles of the loins, 35°.8 C., showing a loss of 0°.6 C.

One hour and nineteen minutes after this observation, temperature of the rectum, 39°.6, and that of the surface of the muscles of the loins, 35°.6 C. Action of heart 13; respiration 11. After considerable effort, the dog was aroused and stood up, and when led by a string, walked slowly for one hundred yards, with great difficulty. During the night, no observations were taken upon his symptoms.

The next morning, June 16th, 24 hours after the first strokes of the Rattlesnake, the dog appeared to be somewhat stronger; but was still very weak and inactive, and presented as upon the previous day, the appearance of a dog asleep with his eyes open. Action of heart, 120 per minute; respiration 24. Temperature of rectum, 38°.5 C. There had been a fall of 1°.9 C., since the last observation. The dog lay with his eyes open, snoring, and at times starting and jumping spasmodically. He was left alone for three hours, and at the end of this time, was found dead and stiff. Rigor-mortis strong and well developed.

Autopsy about 4 *hours after death.* Rigor-mortis complete. Temperature of rectum, 34° C.; left leg greatly swollen, and upon dissection, presented a black purplish, and black appearance, as if dark coagulated blood had been effused amongst all the structures. Wherever the poison had been injected, the same deep black and purplish color of the structures were observed.

Muscles generally presented a dark purplish hue, far different from the appearance in health. Electric currents had no effect whatever.

Blood-vessels of brain not congested with blood, venous blood-vessels running al sides of the spinal marrow distended with black coagula.

Both the right and left cavities of the heart were filled with dark purplish, firm coag blood. The vena cava also was distended with firm, purplish black coagula of vessel as in the previous experiment.

These facts would seem to show that the poison of the Rattlesnake promotes the coagul of the blood. Prussic Acid on the other hand, although acting in a few moments, o contrary destroys to a great extent the coagulating power of the blood.

The right auricle and ventricle of the heart, contained numerous worms, several inch length, and these were surrounded by a firm coagulum of blood. The lungs were p congested with blood, and collapsed but to a slight degree when the thorax was op Blood-vessels of stomach and intestines congested. The mucous membrane of the sto and intestines, was of a purplish color.

The mucous membrane of the small intestines was coated with a reddish and pu bloody looking mucus;—when this was scraped off, it did not appear to be specially cong This corresponded with the appearances during life.

The rectum, both upon the exterior and interior, was of a deep purplish red and b color, and the mucous membrane was covered with the same bloody looking mucus.

The liver presented a deep purplish, brownish color, in places inclining to the slate c Kidneys congested, omentum congested, and redder and darker than normal.

Fore leg which was most swollen, was black as tar or pitch, and resembled in all re except in being much darker, the parts of animals dying within a short time.

The blood corpuscles from these portions appeared more altered than those from the in other parts of the body, which did not present any very well marked alterations.

The dark purplish coagula changed to the arterial hue when exposed to the action o atmosphere.

From the preceding experiments we conclude:

1st. After the injection of the poison of the Crotalus Durissus, (Rattlesnake temperature rises for a brief period; but as soon as the poison has induced a de effect upon the cerebro-spinal nervous system and heart, and coma has been establi the temperature descends. If the animal recovers from this state of coma, the perature will again rise slowly and descend again, upon the supervention of coma.

We have in this rise of the temperature in the first stages, a phenomenon. simi some respects to that of certain fevers, with this difference, that it is less in am and duration.

2d. The Poison of the Crotalus Durissus (Rattlesnake,) acts as a local irritant t the capillaries, and as a destructive agent on the blood and muscular structures, ca congestions and bloody effusions, and softening, and disorganization of the mus fibres.

3d. The blood does not lose its power of coagulating, in every case of poisoning the Rattlesnake, but the clot is soft and voluminous, as if the fibrinous element of blood had undergone some change.

4th. The colored blood corpuscles do not lose their power of absorbing oxygen, change readily to the arterial hue, when exposed to the atmosphere.

5th. Whilst the microscope fails to reveal any marked or characteristic chang the blood corpuscles, in the general mass of the blood, still its direct action on thi is evinced not merely by changes in the coagulating power of the fibrin, but also b congestions of the organs, and the passive hæmorrhage of the mucous membranes

6th. The Poison of the Crotalus, destroys by its direct effects upon the Ce Spinal Centres, and by its depressing effects upon the sympathetic ganglia, and mu structures of the heart; and also by the changes which it induces in the composi the blood.

EXPERIMENTS ON THE EFFECTS OF PUTRID ANIMAL MATTERS.

In connection with the action of poisons, clearly of animal origin, as those Trigonocephalus and Crotalus, it is important to remember that one of the most r able phenomenon presented by animals into whose veins Magendie more than years ago, injected putrid substances, was what is termed *inflammation* of the int that is to say, exhalation of a matter, having the color of *washings of flesh.*

Various observers have pointed out the effects of certain animal substances in raising the temperature when injected into the circulation.

Billroth and Hufschmidt, found that in all the cases in which putrid solutions or recent pus were injected into the subcutaneous tissue, or into the blood, there was a rise of temperature in the rectum, which was considerable even within two hours after the injection, and reached its maximum in from two to twenty-eight hours; that the minimum exceeded the normal temperature by 1°.6 C. (2.88° F.,) and the maximum, 2°.2 C., (3°.96 F.,) and that if the injection was only done once, a rapid defervescence generally set in, shortly after the acme had been reached; whilst on the other hand, after repeated injections death constantly occurred, generally with very high temperatures.

C. Weber has determined by similar experiments, the heat producing and inflammatory effects of pus, of fluids from inflamed tissues, and of pyæmic and septicæmic blood, and even of the blood of an animal merely suffering from simple inflammatory fever, when injected subcutaneously or into serous cavities.

Frese by numerous experiments, showed that the blood of animals suffering from any kind of fever, induced a rise of temperature, when introduced into the circulation of a healthy animal of the same species.

EXPERIMENTS UPON LIVING ANIMALS WITH THE BLOOD FROM THE HEART AND THE BLACK VOMIT FROM THE STOMACH OF YELLOW FEVER CASES.

Experiment 305: With a small "subcutaneous" syringe, I injected beneath the skin of a healthy puppy, about thirty drops of blood taken from the heart of a yellow fever patient three hours after death.

No ill effects were observed.

Experiment 306: In like manner I injected beneath the skin of an active Guinea pig about the same quantity of blood from the *yellow fever heart.*

The next day, October 16th, 1873, the Guinea pig appeared lively, and ate its food. October 17th, the animal appears sluggish and refuses food. October 18th—Animal feeble; moves with difficulty, and is evidently ill from the effects of the injection. October 19th, 5 A. M.—I found the Guinea pig dead, cold and stiff.

Post-Mortem Examination—Body emits a disagreeable odor. cellular tissue of skin and surface discolored and greatly congested around the point of the injection of the yellow fever blood. Cellular tissue and skin softened in those portions around the area of injection. Under the microscope the fluid from these portions of the cellular tissue was found to contain bacteria and revolving animalculæ. Cavities of the heart distended with dark, almost black, loosely coagulated blood. Blood changed rapidly to the arterial hue upon exposure to the atmosphere. Under the microscope the blood corpuscles presented no peculiar alteration. Liver congested. The microscope revealed no accumulation of oil in the textures of the liver. Liver cells distinct but pale. No bacteria, or animal or vegetable organisms, were observed in the blood of the heart, or in the blood and structures of the liver.

Experiment 307: Into the subcutaneous tissue of a large, healthy and active male guinea-pig, I injected about thirty drops of black vomit, taken from the stomach of the yellow fever patient three hours after death.

The black vomit thus carefully injected into the cellular tissue caused the death of this animal in six hours.

Post-Mortem Examination.—Diffused redness, and great capillary congestion of cellular tissue beneath the skin. Congestion greatest in the immediate vicinity of the injection. Body emits a foul putrid odor. Immediately around the point where the black vomit had been injected dark blood had been effused, and the textures presented precisely the appearance of those wounded and poisoned by the fangs of the Rattlesnake or Copperhead.

The cavities of the heart were distended with dark, loosely coagulated blood. No animalculæ, bacteria or fungi, or algæ discovered in the blood. Decomposition rapid; and although the animal was examined almost immediately after death, the odor was disagreeable and resembled that of the black vomit.

Experiment 308: I injected into the subcutaneous tissue of a large, healthy Guinea-pig, about thirty drops of black vomit which I had preserved from a case of yellow fever, ejected shortly before death on the 9th of October, 1873, six days before the present experiment.

Death caused by the black vomit in six hours.

Post-Mortem Examination.—Results similar in all respects to those recorded in the preceding experiment; intense congestion of cellular tissue around locality of injection of black vomit;

no animalculæ or vegetable organisms in blood; putrefaction rapid and marked by foul odor.

Experiment 309: I injected into the subcutaneous tissue of a Guinea-pig about thirty drops of putrid blood, which I had extracted from the cavities of the heart of a subject who had died six days before, on the 9th of October, in a "*congestive*" malarial chill.

Death caused by the putrid malarial blood in eight hours.

Post-mortem changes similar to those recorded in experiments third and fourth.

The preceding experiments are of importance in establishing the fact that *black vomit, taken from the stomach immediately after death, or ejected during life in yellow fever, will, when injected into the subcutaneous tissue, produce as deadly and as rapidly fatal results as putrid blood.*

We deduce the following practical conclusions:

First. BLACK VOMIT, when absorbed into the circulatory system, may act as a deadly SEPTIC POISON.

Second. As the capillaries of the stomach in yellow fever are often ruptured, and the epithelium of the mucous membrane denuded, it is possible that in some cases the absorption of black vomit, especially after it has undergone putrefactive changes in the stomach, may be an important cause of the fatal issue.

Third. If remedies could be used which would prevent putrefactive changes in the black vomit and render it comparatively inert, a certain proportion of cases might be rescued, after the appearance of black vomit.

The preceding experiments and reasoning led me to employ the SULPHO CARBOLATE OF SODIUM, in doses of 20 grains, every 4 or 6 hours in the treatment of yellow fever.

I have used the *sulpho carbolate of sodium* in about forty cases of yellow fever, with satisfactory results.

I find that it is readily borne by the stomach at all stages of the disease; that so far from exciting nausea or vomiting, it often modifies and arrests these distressing symptoms.

It appeared in some cases to arrest the decomposition of the black vomit. One case accompanied by a temperature of 107°.1′, and attended with black vomit recovered under its use, combined with ice water injections into the rectum.

At some future time we hope to present statements of these cases.

Davaine claims to have made the following discoveries: After injecting beneath the skin of an animal's neck a single drop of putrid blood, the surrounding tissue became extensively infiltrated, and death soon followed with symptoms of septicæmia. The blood of this animal was then employed to inject other animals in a similar way, and was found to be more poisonous than the original putrid blood. A third and fourth animal was then injected, each with the blood of the preceding one, and in this way 24 in all were experimented on. The results seemed to show that the toxic power of the septic material increases by dilution.

Stricker, in a series of experiments undertaken to test these statements, inoculated 23 animals with healthy, 23 with putrid, and 73 with blood diluted by transmission. Of the first series, 4 died. Of the second series 11 died. In experiments with diluted blood, when it had passed through 13 different animals, 53 of the 73 died. From this it appears that even the very small amount of $\frac{1}{1256}$ of a cubic centimeter of poisonous material could cause death when injected hypodermically. Davaine's statement, that organisms form in the blood and increase by every transmission, was not sustained by investigation. Stricker found numerous colorless bodies in the blood of these animals, but he did not regard them as organisms, but rather as proto-plasmic bodies.

The following facts he regards as ascertained:

1. That transmission greatly increases the injurious and fatal action of the putrid matter.
2. That the original disease was infectious, but that through inoculation it became contagious.
3. That though it be not proven, yet it is probable that the special poison is a living contagion (*contagium animatum*,) for such rapid proliferation is only possible in organized material.
4. That the poison is diffusible and is not destroyed by boiling (*Allg. Wien. Med. Zeitung*, 20, 1873; *New York Medical Record*, July 1st, 1873, p. 311.)

If it be true that the poison of yellow fever may be generated in human beings under certain conditions of the constitution, and more especially of the chemical and physical constitution of the blood and of the nervous and muscular structures, when subjected to the combined influences of heat and crowding in an impure atmosphere; if it be still farther true that decomposition, both before and after death, is more rapid than in any other form of disease, and if this decomposition forms the most favorable condition for the rapid multiplication of bacteria and fungi, and other simple organisms; it is reasonable, in the light of the preceding experiments of Davaine and Stricker, to suppose that these organisms may become *carriers* of the poison, and may constitute an important medium of its dissemination from the original foci.

Magendie has shown by actual experiments on living animals that an excess of alkalinity in the blood, interferes not only with the freedom of the passage of this liquid through the capillary vessels and diminishes the property of coagulation, but also, when thus modified, the blood tends to penetrate the walls of the capillaries by imbibition, and to produce those disorders in the mucous membrane, which have long been known under the name of inflammation.

Magendie by injecting carbonate of soda, into the veins of animals, produced œdema of the lungs, with its pathogmomonic signs, at the outset, and cadaveric lesions when it causes death. Thus proving that when the blood becomes surcharged with an alkaline principle, its serous matter increases in quantity, escapes from its vessels among the lobular ramifications of the lungs, distends and bursts them, and carrying with it the coagulable part, in a semi-liquid state, collects in irregular masses, which appear to be formed in large measure of fibrinate of soda and potassa.

On comparing the disorders caused by spontaneous excess of alkalinity in the blood, with those produced by injecting carbonate of soda into the veins, or by a frequent repetition of blood-letting, Magendie found the same symptoms and similar results.

If any substance possessing the property of combining chemically and of forming salts with the fibrin, such as fibrinate of soda, potassa, or ammonia, be injected into the veins of a living animal, the fibrin will loose its coagulability, and this change affects the blood generally, and although it may contain the usual proportion of fibrin, it becomes unfit for circulation, and stagnates in the capillaries, and especially in the pulmonary vessels, and local lesions, as apoplexy, hæmorrhage, or hepatization follow.

Magendie has in like manner, tested the effects of defibrination upon the process of inflammation during the reparation of wounds.

He selected a dog from whom he had successively removed several portions of fibrin. A longitudinal incision was made through the skin, and some depth of muscle in the anterior and middle part of the neck. The blood that escaped from the divided vessels appeared more liquid than usual; it did not coagulate on the blade of the bistoury. The lips of the wound were united by the twisted suture, and the animal left to himself. The animal survived the operation a few days only. An examination of the wound after death, revealed the absence of any real adhesion by coagulable lymph, and the divided tissues were discolored, dry and hardly at all swollen.

The older writers were acquainted with the fact that alkaline salts prevented the coagulation of the blood, and John Huxham in his *Essay of Fevers*, uses this fact to explain the changes of the blood in Scurvy and Putrid Petechial Fevers.

> It is well known that volatile alkali salts mixed with the blood, when just drawn, or rather after it runs from the vein, keep it from coagulating and hinder it from separating into crasamentum and serum, as usual. The experiment is easy, and every one will find it true on trial. This very adequately resembles the blood drawn from the bleeding scorbutics, and also from most persons that labor under putrid petechial fevers, when the blood is drawn very early in the disease.
>
> All humors of the body, actually putrified, become a strong Alkali, and putrid blood loses its consistence, and soon after its color, running into a yellowish dark colored sanies. The blood drawn in some greatly putrid petechial fevers, hath had this appearance, and been observed actually to stink as soon as drawn, as well as the urine, as soon as made; so far was the putrefaction advanced, whilst even life was still subsiding. The surprisingly great and speedy corruption of bodies dying of pestilential fevers with spots, shows this likewise; I have known such a *corpse air* as much, as they call it in seven or eight hours, as dead bodies commonly do in seven or eight days, and to leak out a most putrid *sanies*, from all the outlets of the body: which, by-the-bye, is a reason why persons dying of such fevers, should be buried very soon."—An Essay on Fevers, etc., by John Huxham, M. D., 1757, pp. 50, 51.

Andral has shown that in the diminution of the fibrin, relatively to the Globules, we must recognize the grand condition of the blood favorable to the production of hæmorrhages; and in his investigations he found the relation of these two factors so constant that he found it impossible not to regard the one as the cause of the other.

In Scurvy the proportion of globules is natural, or varies within narrow limits, whilst the quantity of the fibrin is diminished, and its coagulative quality is at the same time altered; and this condition is most favorable to the production of repeated and profuse hæmorrhages.

The tendency of the formation of petechial and livid spots, during the progress of malignant fevers, in the middle ages, is referable chiefly to the scorbutic condition of most patients, at those times, when salt meat constituted the chief nutriment during a large portion of the year, and fresh vegetables were almost unknown. In this connection it should be remembered, that authors have declared, that they have found an excess of alkaline matters in the imperfectly coagulated blood of persons who have died of low-fevers or Scurvy, attended with livid petechiæ and spots. An analogous result was announced by M. Frémy and Andral.

Without doubt the supposition is correct that the peculiar hygienic condition of the people of Europe, before the eighteenth century, caused them to be frequently attacked with diseases, one of whose principal elements, it not their starting point, was a state of dissolution of the blood. The dissolved and incoagulable blood, petechial and passive hæmorrhages, so constantly described by authors, in their histories of epidemic fevers, in the middle ages, are most philosophically referred in a measure at least, to the scorbutic state of the blood of the patients, and to the bad ventilation and filthy habits of the times. In the epidemics which prevailed in Europe during the middle ages, it was common to observe gangrene, hæmorrhage from various parts, extensive ecchymosis, or thousands of petechiæ covering the skin, whilst the symptoms of Typhoid Fever, and of the various contagious eruptive fevers, developed themselves with a high degree of intensity, and the greatest rapidity. These affections were the external manifestation of an internal condition of the blood.

Erasmus, the philosopher, who flourished towards the close of the sixteenth century, wrote that in his day, the inhabitants of London, were every year, from spring to harvest, attacked by a malignant fever, which committed the greatest ravages in that city, and especially amongst the poorer classes.

"The supply of water" Erasmus says: "fails the inhabitants; they have to seek it at a great distance from the city; the river water is carried on their backs, and is so dear that the poor cannot procure enough of it to wash themselves, and keep their houses clean. These houses are of wood, and very cold in winter, which makes it necessary to fill the rooms with straw. But as this cannot be often renewed, it becomes spoiled and very injurious."

Grant, who practiced medicine, and wrote towards the close of the last century, suggested the inquiry, whether the peculiar hygienic condition of the people of Europe, before the eighteenth century, must not have caused them to be frequently attacked with diseases, one of whose principal elements, if not their starting point, was a state of dissolution of the blood. It is certainly remarkable, that the observers of preceding ages, constantly speak of dissolved and incoagulable blood, in their histories of epidemics.

Huxham in his Essay on Fevers, has given a large number of observations, illustrating the great tendency to Petechiæ and passive hæmorrhages, in the fevers of those times.

Andral in treating of the changes of the blood in Scurvy, records the disappearance of this disease, and of the great febrile epidemics of the middle ages, and says:

> "We must therefore admit, that in consequence of the change in the nature of the influences which necessarily act upon men, the blood which receives before the solids, the impression of the greater part of these influences, must present changes in its constitution proportioned to those undergone by the agents which operate upon it. It would appear then, that there must have been a time, when a very peculiar constitution of the blood engendered maladies, which in certain respects, may have differed from those now observed, and may not have required the same treatment. And thus it is that at different periods of the existence of our race, and the diversity of influences to which it may be subjected, diseases of very different types may arise, and undergo changes in their essential nature, which are revealed to us by the specific character of their symptoms."

Andral has likewise established this invariable law, of augmentation in the fibrin of the blood, in regard to every acute inflammation of the serous membranes; and this increase was very marked in a case of Cerebro-Spinal Meningitis, in which after death, Andral found the Spinal Marrow surrounded in its whole extent, by a sort of purulent sheath, the pus having infiltrated the pia-mater.

In the following case of softening of the brain, Andral, in like manner, discovered an increase of fibrin.

Case 632.—A woman was brought to the hospital, laboring under a recent attack of apoplexy. Her limbs were paralyzed and rigidly flexed. The patient was bled, and Andral was surprised to find a larger quantity of fibrin in her blood (4.5,) than is usually found in simple hæmorrhages. She soon died, and the autopsy disclosed in the right corpus striatum, and around a clot, a red softening of the cerebral substance of small extent, but very distinct. Inflammation had then existed around the apoplectic centre; the contraction of the paralyzed extremities had indicated it during life, and the excess of fibrin in the blood had added to the value of the sign. It should also be remarked here, that if the excess of fibrin was small, the inflammatory complication was also very limited.

In Tubercular Meningitis on the other hand, there appears to be no increase of the fibrinous element of the blood.

Andral has given us the results of his investigations on the changes of the blood in Tuberculosis and in Cancerous Cachexia, (Carcinoma,) that: So long as Tubercle and Cancer preserve the character of hard masses without any inflammation around them, an analysis of the blood, uniformly gives the normal quantity of fibrin; but as the softening of these hard masses advances, and a process of elimination analogous to that of inflammation, is set up around them, the blood becomes more and more charged with fibrin; so that the excessive formation of this principle is not due to the development of the accidental production, but wholly to the inflammation excited by the latter, at certain stages of its existence.

Andral has recorded the following remarkable case, in which tubercles developed in the pia-mater simulated acute meningitis; but the qualities of the blood, even before the autopsy, excited doubts regarding the existence of the latter disease.

Case 633.—A seamstress, 24 years of age, entered the hospital of La Charité, May 27th, 1841, complaining of having had a cough and shortness of breath for some time; she stated that she suffered from continual headache; on May 18th, she met with a serious disappointment, and a few days afterwards her headache increased; from that epoch she experienced creeping chills. From May 23d, she grew more seriously ill; on that day her headache was unusually severe, and at the same time she had humming noises in her ears, intolerance of light and bilious vomiting. From the 27th to the 30th of May, the symptoms of an acute cerebral affection grew more and more distinct. From May 30 to the day of her death, which happened June 5th, she uttered piercing cries like those called hydrocephalic; there were delirium, strabismus, rigid flexure of the limbs; distressing moans and convulsive movements whenever the skin of the trunk or limbs, which seemed to have its sensibility greatly exalted, was at all rudely touched; and towards the close tetanic rigidity of the neck.

At the autopsy the pia-mater was found thickly studded with tuberculous granulations, which were collected most numerously about the fissures of Sylvius. In no other part, either of the brain or its membranes, was any appreciable alteration detected. Tuberculous granulations, similar to those which filled the pia-mater, were also found in the pleuræ of both sides, and in the peritoneum, both of which membranes were covered with them; both lungs were filled with miliary tubercles. The only lesion revealed by dissection was the equal development in all the great serous membranes, and in the lungs of small hard tubercles, with no signs of inflammation around them. The anatomical characters of Meningitis were completely wanting.

When the analysis of the blood in this case is examined; at the first bleeding 3.0 parts in the thousand, were found of fibrin, and at the second 3.4; so that the quantity of this constituent of the blood did not exceed its physiological limits. During the life of the patient this result was viewed with astonishment; it seemed strange that in a disease which appeared to be acute meningitis, the amount of fibrin should not be increased; the autopsy explained this anomaly and rather showed that the anomaly was only apparent.

Andral cites this case (633,) as the strongest evidence, that whatever may be the extent or the rapidity of the formation of tubercles, it does not in the beginning, augment the fibrin in the blood.

The changes of the blood in certain cases of Cerebro-Spinal Meningitis, may have been the *result* and not the *cause* of the *aberrated* nervous actions. If this be true, the *petechiæ* and spots, observed in a certain proportion of the cases, should not be regarded as true cutaneous eruptions, like the cutaneous affections characteristic of the exanthemata.

It has been said, that extreme agitation of the nervous system, may deprive the blood of its power to coagulate. According to several observers, a similar effect may be produced by a strong moral emotion, a concussion of the brain, the destruction of a certain portion of the spinal marrow or a violent blow upon the pit of the stomach, affecting the nervous plexus of that region. If facts of this class were appropriately verified, they would doubtless be of the highest importance; for they would show that the nervous system exerts a powerful influence over the constitution of the blood, and that consequently a lesion of innervation may deteriorate the blood, just as an alteration of the blood may modify the nervous action. Professor Dupuy announced, that by dividing the pneumogastric nerves in horses, the blood of these animals lost its property of coagulating; Dr. Mayer, on the other hand, having tied the pneumogastric nerves in living animals, found that uniformly the blood had coagulated throughout the whole pulmonary circulation. These facts, as well as those relating to the effects of lightning, excessive heat and excessive exercise in warm weather, require additional proof. If it be true that the changes of the blood may be in accordance with the portion of the nervous system affected, as in section of the pneumogastric and sympathetic, it may be inferred that the changes of the blood in Cerebro-Spinal Meningitis may vary within certain limits with the portion of the nervous system chiefly involved.

THE DERANGEMENTS OF THE CIRCULATION AND RESPIRATION, AND OF THE SECRETIONS AND EXCRETIONS, AS WELL AS OF THE NERVOUS FUNCTIONS IN CEREBRO-SPINAL MENINGITIS, MAY ALL BE REFERRED TO THE LOCAL INFLAMMATION, CONGESTION AND ALTERATION OF THE MENINGES, (ESPECIALLY THE PIA-MATER) AND STRUCTURES OF THE BRAIN AND SPINAL CORD.

The theory, that the cold stage, the febrile phenomena, the derangements of circulation and respiration, and the mottling and discoloration of the surface, are due to the action of a distinct blood poison which so alters the constituents of the blood that it stagnates in the capillaries, and transudes through their walls into the surrounding tissues, is not necessary for the explanation of the phenomena, and is not borne out by the natural history of the disease.

Derangement in the action of the nerves given off from the base of the brain and of the medulla oblongata, caused by the inflammation of the pia-mater, and disturbances in the nutrition of the ganglionic cells, and by the mechanical pressure of the products of inflammatory action, are sufficient to cause the derangements of circulation and respiration, and the stagnation and alteration of the blood in the capillaries of the surface, and the consequent mottling of the skin as in Malignant Malarial Fever.

Not only is the fibrin increased in the blood in Cerebro-Spinal Meningitis, but all marks of disorganized blood and of bloody effusions in consequence of disorganization of the constituents of the blood, are absent from the structure most inflamed and diseased, viz: the pia-mater of the brain and spinal cord. The appearance of effusions of blood and bloody serum, into the cavity of the cranium and spinal canal, described by some observers, may be referred to the rough manipulation of the post-mortem examination, and to post-mortem changes and exudations of the coloring matters of the blood.

The facts point chiefly to a want of oxygenation of the blood, and to a tendency to the stagnation of the venous blood in the capillaries of the periphery, and not to a distinctive eruption, as in Typhus Fever, Measles and Scarlet Fever, nor to actual effusions of altered blood.

If it can be shown by actual experiment, that irregular capillary action and congestion are dependent upon deranged nervous action, it is unnecessary in this connection to do more than allude to the effects of pressure on the medulla oblongata upon the functions of circulation and respiration.

Those writers appear to have been led into error, who attribute the mottled appearance, and petechiæ of the surface, and the changes of the secretions, as well as the marked disturbances of the circulatory and respiratory systems in Cerebro-Spinal Meningitis, to the exclusive action of a fever poison disorganizing the blood.

In the first place, these capillary congestions, with their stagnant and dark blood, cannot partake of the nature of a specific exanthemic eruption, because they are found in many cases in the mucous and serous membranes.

The "*inflammatory*" blood, whenever stagnant, from whatever cause, whether a local injury, or from loss of contractile force in the capillaries, consequent on deranged nervous action, would tend to throw out fibrinous effusions. Or perhaps it may more correctly be expressed thus, the liquor sanguinis exuding from the stagnant blood would contain a larger proportion of inflammatory lymph.

In the second place, the mottling and petechiæ of the skin are by no means present in all cases of Cerebro-Spinal Meningitis. This has been in accordance with my experience, and many other observers have recorded the same fact. And in this connection, it will be important to enter somewhat at length into a consideration of the character of these congestions of the capillaries of the skin, as determined by the impartial statements of the best observers.

Dr. E. Hale, in his description of the "Spotted Fever," which prevailed at Gardiner, Maine, in the spring of 1814, thus draws a distinction between the spots or small patches of a purple or livid color, which occurred most frequently in the fatal cases, and an eruption or slight efflorescence of the skin, attended with redness, heat and itching, which was a common symptom during recovery.

> "I have hitherto said nothing of any spots upon the skin, although their real or supposed appearance has in many places given a name to the disease. The reason is that I have very little to say respecting them. In most or all the fatal cases, just before death, small patches of a purple, or rather livid color, were irregularly dispersed over the surface of the body. They had a considerable resemblance, in their appearance, to small extravasations of blood into the cellular membrane, and were probably produced by the stagnation of that fluid in the small vessels of the skin.
>
> In two or three other cases, spots somewhat similar to these, in their appearance, but of a livid color, were discovered at an earlier stage of the disease. But they occurred early in the season, and only where the fever had continued several days without any steps having been taken for its removal. They disappeared as soon as the skin was excited to action, either by friction or by internal remedies. I have never observed any tendency to the production of these spots while the skin was moist, except in the fatal cases already mentioned, unless the eruption formerly described as taking place during the convalescence, is to be confounded with them, and this was exceedingly dissimilar in its appearance." pp. 95, 96.

The observation of Dr. Hale, that these spots disappeared as soon as the skin was excited to action, either by friction or by internal remedies, is highly important, as indicating that these spots were in no wise an eruption, but were produced by the stagnation of the blood in the small vessels of the skin. This explanation is sustained also by the testimony of Dr Hale, as to the increase in the number and size of the spots in the last moments of life, and in the article of death:

> "The livid spots which had begun a short time before, increased at the moment of death, and assumed much of the appearance of incipient sphacelation, for which they were often taken by the attendants." p. 109.

Dr. Hale thus describes the eruption which sometimes occurred during convalescence:

> "After the epidemic season had considerably advanced, an eruption on the skin very common symptom during recovery. It did not appear in but few, if any cases, about the 1st of April, but after that time almost every patient was subject to it. in its appearance in different cases, but generally was a slight efflorescence on the attended with redness, heat and itching. The skin was very slightly elevated and commonly not pimpled. It subsided in two or three days of its own accord, leaving a scale upon the skin from the desquamation of the cuticle.
>
> "This eruption seems not to have been in any degree critical. It did not usually until after the most severe symptoms of the disease had been relieved for several days, and was not attended or followed by any very observable additional amendment. Neither, on other hand, did it appear to increase the fever, or in any way add to the sufferings of patients, except by the external heat and irritation, which were not often severe. perhaps be a question, whether the eruption is not attributable to the treatment, rather to the disease itself." p. 81.

Dr. Hale also describes a species of boil, or carbuncle, as another common affection the skin and cellular membrane during convalescence.

> "It did not commence until the cure was considerably advanced, generally several after the eruption had disappeared, and sometimes not until the patient has so far recovered as to have left his chamber. It was an exceedingly painful swelling, beginning in the a small pustule, which discharged a slight quantity of yellowish, ichorous fluid, and rounded by an areola, which was of a bright red color, and hard; the hardness extended deep into the cellular substance, and attended by a burning, itching sort of pain. inflammation rapidly extended itself, the centre became considerably elevated, and to a deep purple, and almost black color. In a few days it ulcerated, and cast off a ous slough, and then soon healed. The discharge from it was never very copious. tumors varied very much in their size, and in the extent of the inflammation. In some slough was not larger than a small pea, and the areolar not more than two or three inches circumference. In others, the slough was an inch or more in circumference, and the circle inflammation as large as a small plate." pp. 82–84.

Dr. Joseph A. Gallup, in his "Sketches of the Epidemic Diseases in the State Vermont," states that the eruption, which had given the name to the disease, was constant attendant, and he estimated the proportion of the cases which had eruptions, at about *only one-sixth.*

Dr. Elisha North says that petechiæ were by no means constant, and Drs. Welsh, James Jackson and John C. Warren describe the petechiæ and occurring "in comparatively few cases of the disease. They are of worse proportion as they are more dark colored." According to these observers, they not always found in fatal cases, nor confined to such.

In fifty-seven cases, in which Dr. Ames, of Alabama, noted the state of the purple petechiæ, which did not disappear upon pressure, occurred in only one and an eruption around the mouth (herpes labialis) was observed in three cases.

Of the 96 cases recorded by Dr. Githens, "thirty-six had marked petechial tions, not disappearing under pressure; thirteen had mixed petechiæ and nine erythema and urticaria; three had indistinct petechial mottlings; and in seven cases there was no eruption at all. If present, it usually appeared early; in many cases the first diagnostic mark; and although showing, perhaps the of the vital fluid, it did not seem to have any reference to the degree of inflammation, or to the prognosis." Am. Jour. Med. Sci., July, 1867, p. 35.

Some observers, both in Europe and America, who have met this disease, have observed petechiæ at all; and most writers agree that they are not pathognomic, any marked import.

According to Dr. J. Baxter Upham, of Boston, Petechial spots were only 55 cases in 315 cases of Cerebro-Spinal Meningitis. He describes the this limited number of cases, to have been generally of a hæmic character, and resembled those seen in the worst cases of Typhus. Boston Medical and Journal, vol. xci; Sept. 3d, 1874, p. 225.

We are in like manner justified in the conclusion that none of the other and eruptions of the skin are characteristic or essential elements of Cerebro-Spinal Meningitis, for in a large proportion of the cases, they do not appear at all, and many other diseases present similar phenomena.

CEREBRO-SPINAL MENINGITIS, RESEMBLES IN ITS ORIGIN AND PROGRESS INFLAMMATORY DISEASES, AND HAS FREQUENTLY PREVAILED AT THE SAME TIME, AND HAS BEEN INTIMATELY ASSOCIATED WITH INFLUENZA AND PNEUMONIA.

No less an authority than Dr. Nathan Smith, taught that "*Spotted Fever*" resembled epidemic catarrh, and in fact might be a variety of that disease. After a careful examination of his "*Practical Essay on Typhus Fever*," we find that in this celebrated description, of what we now call *Typhoid Fever*, no allusion is made to the Spotted Fever, but his observations upon this disease will be found in his "*Notes and Additions*" to the "*Treatise on Febrile Diseases, Etc.*, by A. P. Wilson Philip, M. D.," published in Hartford, Connecticut, 1816.

Dr. Smith, in his note upon Epidemic Catarrh, says:

> "In my note on peripneumonia notha, I remarked that the catarrh assumes a great variety of forms, and affected different parts of the body at different times. * *
>
> "A judicious physician has observed that the spotted fever, is a particular form of catarrh. In the winter of 1813, in that part of the country where the pneumonia typhoidia prevailed, the spotted fever was prevalent at the same time among children. It was common for the adults in families to have the pneumonia; and the children in the same families to have the spotted fever at the same time, which induced one to infer, that the two diseases were somehow connected together.

In his note upon Peripneumonia Notha, to which he refers in the passage just quoted, Dr. Nathan Smith, refers to the ancient origin or existence of this disease, pronounces it a true epidemic, and shows that it belongs to the class of inflammatory diseases, and is characterized by the inflammation of mucous and serous membranes, and the exudation of coagulable lymph.

In his comments upon Dr. A. P. Wilson Philips' description of Typhus Fever, Dr. Nathan Smith presents the substance of his "Practical Essay on Typhus Fever," published ten years afterwards; and in the Notes on Petechial Fever, which Dr. Philip considers immediately after Typhus, Dr. Smith takes the ground that the petechial fever, as described by Dr. Philip, was only a variety of Typhus, and wholly distinct from the disease called Spotted Fever in New England. Thus Dr. Smith says:

> "Respecting the disease called Spotted Fever in New England, although the name may be improper, as spots do not constantly appear, yet, by it we understand a disease of a peculiar character, differing in several respects from any other. * *
>
> "I have mentioned in a note upon epidemic catarrh, some facts, which go to show, that the spotted fever may be a variety of that disease. The following circumstances would lead us to believe that it depended on a peculiar morbid excitement of the capillary vessels in the brain, which soon extended itself to this system of vessels throughout the body. The disease attacks suddenly. The arteries of the neck and temples beat strongly, the head is hot while the pulse at the wrist is small, and the extremities cool. The functions of animal life are soon impaired or lost.
>
> "Several persons affected with this disease, who have recovered their health, have lost the sense of hearing; and others have been affected with blindness for several weeks. In one case it affected the muscles of voluntary motion with tremors, which has ever since deprived the patient of the power of walking." "A Treatise on Febrile Diseases, etc., by A. P. Wilson Philip, M. D., etc., with Notes and Additions by Nathan Smith, M. D., Professor of Physic, Surgery and Obsteterics, in Yale College," in two volumes. Hartford: printed by Benjamin L. Hamlin, 1816, vol. i, p. 213–219; vol. ii, pp. 206–361.

Dr. Gallup considered the peculiar habit of the disease, called *Spotted Fever*, as generally,

> "The offspring of cold climates, and cold seasons of the year. With a few exceptions, it has broken out in the coldest seasons, and spread most alarmingly at such times in the different places it has visited. The months of January and February have oftenest given rise to

> it in point of seasonw hen it rages considerably; it continues perhaps to the middle of the month of May, and then passes off gradually like other epidemics."

This author affirmed that the most severe epidemic disease that had ever afflicted the inhabitants of Vermont, the epidemic peripneumony of the autumn of 1812, and winter of 1813, presented the general features of the disease, that had been in the State for about two years, called *Spotted Fever:*

> "The chief difference seemed to be, that now, the greatest force of local affection fell upon the lungs. * *
>
> "The chief difference seems to consist in the locality of the principal affection. In the disease of 1810, '11 and '12, it was in the head; in 1813, it was in the thorax. And these circumstances go far in explaining the phenomena of the two diseases. Neither of the diseases was strictly confined to one of these parts, or the other. When most in the head, the diseased affection could be slightly traced in the thorax; and when in the thorax, some could be traced in the membranes of the head." Loc. Cit., pp. 69, 70, 283, 284.

Dr. Gallup also alludes to the fact, that the epidemic cause, affected both domestic and wild animals, and a large number of Foxes and Squirrels died suddenly.

Dr. E. Hale, in his history of the "*Spotted Fever*," which prevailed at Gardiner, Maine, in the spring of 1814, in like manner, observed, that

> "The epidemic throughout its whole course, was remarkably affected by the state of the weather, and especially by any sudden change in the temperature. * * A few days of unusual cold, seemed to render all the existing cases more severe, and at the same time, produced a greater number of new attacks; while on the contrary, a change from cold to milder weather produced a corresponding effect in mitigating the symptoms and lessening the ravages of the disease."

The disease commenced early in the autumn of 1813, in remote towns, and as winter extended, the epidemic continued to spread over a larger extent of country. The first case in Gardiner, to which Dr. Hale was called, was on the 11th of February; throughout the month of March, the Epidemic extended itself rapidly in all directions; the progress of the epidemic began to abate early in the month of April, and terminated its course in Gardiner, with the close of May. Many of the writers who have recorded observations upon Cerebro-Spinal Meningitis, have failed to give careful records of the weather and accompanying diseases, but in addition to the strong and clear testimony just recorded, an immense mass of facts exist, to show that the disease generally, if not invariably, appears during cold, changeable and wet weather in autumn, winter and spring along with some pulmonary complaints.

It appeared in the Confederate Army, at Bowling Green, during the winter of 1861, 1862; in the succeeding winter it attacked the troops of the army of Northern Virginia, encamped upon the snow-clad hills around Fredericksburg, and about the same time, it appeared in the Department of South Carolina, Georgia, and Florida, on the Atlantic and Gulf Coasts, in the Army of the West at Grenada, Mississippi, and amongst the negroes employed upon the fortifications, and also amongst the plantation hands, in several adjoining counties; during the winter of 1863, 1864, it proved very fatal amongst the blacks at Mobile, and finally, it appeared in various parts of the Confederate States during the winter and spring of 1864–5. Some were disposed to connect its appearance and spread, with the assembling of large armies, but its occurrence amongst the citizens, in remote and comparatively isolated villages and towns, and its appearance also in the sparsely settled districts, at the same period of the year, would indicate that the disease was due to a general epidemic influence. The fact that the number of cases was relatively greater amongst the troops and negroes in service, is readily explained on the ground that these men were more exposed to cold and wet, and at the same time subjected to those depressing influences, as scant diet, fatigue and mental anxiety, which render the system liable to the action of all epidemic influences. The sick and mortuary reports of the Confederate Army, show that Pneumonia and Pleurisy and Catarrh, were far more prevalent and serious in their effects amongst the than amongst the citizens. And there is no doubt, but that the fever, which d in, and spread from the large armies in Europe, following in their trains, and g over the country, at various times during the last and present century, was e contagious petechial Typhus fever, and not the disease under consideration.

ro-Spinal Meningitis accompanied with Malignant Pneumonia, prevailed in Ger- n 1508; the epidemic of 1557, which prevailed in the environs of Poitiers, La e, Angoulême and Bordeaux, commenced in the *spring* and was so destructive, ording to the expression of Coyttarus, the sick seemed to die rather from fear m the disease itself; the epidemic which showed itself in 1587, in Lombardy, d during the winter, and in the spring, it was complicated with pleurisy; the scribed by Sydenham, under the name of *febris nova*, supposed by many to be -Spinal Meningitis, commenced in the month of February, 1685, after a severe and was at first considered by Sydenham to be the same as peripneumonia; the which appeared in a portion of the Army of Mont Blanc in 1814, prevailed the months of February, March and April, amongst the new recruits, who had ed very hard service, always in the snow, and exposed day and night to great ; numerous other instances might be given illustrating the prevalence of this during the winter and spring, as the epidemic at the Univerisity of Cambridge, d, in 1815; that of Dublin, Ireland, and vicinity, during the winters of 1813, that of the galley slaves confined at Toulon, during the winters 1829–30; the s of England and France from 1832–1842; the epidemics of the United States, 06 to 1866.

e epidemic of Montgomery, Alabama, described by Dr. Ames, the disease made rance early in February, was most prevalent in March, and disappeared as an in the latter part of April.

. Jewell, in his annual report on the Meteorology and Epidemics of Philadelphia , describes the epidemic of Cerebro-Spinal Meningitis, as commencing in Feb- nd as being intimately associated with an epidemic Catarrh or influenza.— *tions of the College of Physicians of Philadelphia, 1862–1864, p. 79, 80.*

wick, on the 6th of April, 1864, presented a paper to the College of Physicians delphia, in which he supports the view that the "*Spotted Fever*," which had in Philadelphia, was but a form of Epidemic Influenza.

G. Webber, in his Prize Essay on Cerebro-Spinal Meningitis, after recording cts from various authors illustrating the effects of the weather, and of low damp s upon the origin and spread of Cerebro-Spinal Meningitis arrives at the fol- general conclusions:

> nfluences, then, which have been recognized as causes of this disease are unusual which seems to have a peculiarly powerful effect upon soldiers lately enlisted; all ing influences; over-crowding in badly ventilated apartments; want of cleanliness; variations of temperature, especially when combined with damp and wet weather; ion near marshes or considerable bodies of water and lack of proper drainage. n has but little influence, except as previously stated, under very favorable circum- Malaria has been mentioned by some observers, but if they mean that condition of sphere which causes periodical diseases, and not a peculiar influence, *sui generis* upon is epidemic depends, there is no evidence of its existence.
>
> btedly an epidemic condition of the atmosphere is the principal cause of this affec- he other causes do not all exist at the same time, and sometimes none of them can be d; and again, most of them may co-exist without giving rise to this peculiar disease. then refer it to some hidden and hitherto undiscovered cause operating upon all and g the disease, only in those most susceptible to its influence, or who have been most to the pre-disposing causes, and that cause has been called an epidemic condition of sphere, which will answer well enough until its true nature is discovered. Whatever ence is, it has frequently affected other diseases, assimilating them more or less to "

ave shown that the changes of the temperature during the progress of Cerebro- eningitis, indicate the action of the agent producing the disease directly upon the cerebro-spinal nervous system, rather than upon the blood; in other words, the changes of the temperature, are due rather to the lesions of the nervous system than to the action of a fever poison upon the blood.

THE CONDITIONS OF MANY PATIENTS DURING CONVALESCENCE FROM CEREBRO-SPINAL MENINGITIS INDICATE IN THE CLEAREST MANNER, THAT THE CEREBRO-SPINAL NERVOUS SYSTEM HAS BEEN INFLAMED, AND PARTS OF THE STRUCTURES PERMANENTLY ALTERED, RATHER THAN THAT THERE HAD BEEN NOTHING MORE THAN THE ACTION OF A SPECIAL POISON UPON THE BLOOD.

An explanation of the almost universally fatal character of Cerebro-Spinal Meningitis, as well as of the tedious nature of recoveries from the disease, may be found in the physiological actions of the nervous structures involved, and in the nature and effects of the products of the inflammatory action. The prognosis of every well defined case of this disease must be doubtful and unfavorable.

Aside from the direct action of the morbific agent upon the nerve ganglionic cells and commissures, it can readily be conceived, that the inflammation of the nutritive membrane, and the coating of the most important and delicate organs confined in a bony case, with a dense exudation tending to organize itself progressively into more firm and resisting structure, might give rise to the phenomena of Cerebro-Spinal Meningitis.

Even after the subsidence of all active inflammation in the meninges of the brain and spinal cord, the most serious consequences may follow, and all the dangerous symptoms and derangements of the most essential functions of life may be kept up by the mere mechanical action of the organizable and organizing fibrous effusion.

The period of convalescence from this disease depends, not only upon the amount of fibrinous inflammatory effusion, but also upon the character and rapidity of the subsequent changes, resulting in the gradual absorption of some portions of the products of the diseased action.

Dr. Nathan Smith recorded the important observation, that in the *Spotted Fever* of 1813, several persons affected with the disease who recovered, lost their hearing and sight, and in one case the lower limbs were paralyzed.

Dr. Gallup appears to have been the first author who described a peculiar state of chronic illness, often continuing for months and even years, and characterized by loss of muscular and nervous power, pains in the head and various portions of the body and extremities, inability to endure prolonged mental and physical effort which followed Spotted Fever.

A careful examination of the full and accurate description given by Dr. Gallup, of the "*Sequelæ of Spotted Fever*," in the sixth section of his work, will show that the symptoms which he describes, were due to the lesions of the cerebro-spinal nervous system.

Dr. Gallup refers to an obstinate case of this kind, attended with pain in the head (hemicrania) and tetanus, which finally ended in a state of deafness and idiotism.

Dr. Gallup also recorded the important practical observation illustrating the inflammatory nature of this disease, that:

> "Although there is a great degree of debility in the organs of locomotion, a small pulse, and a deficient circulation in the extreme vessels, the subjects of this disease bear bleeding, puking, purging and moderate sweating to a great degree, without growing weaker or showing many signs of increased debility. Not only this, but it is a fact capable of demonstration, that where these remedies are freely used the patient grows stronger, as soon as the fatigue and immediate depression is over, which is only a short time.
>
> "The circulation becomes more perfect, as is proved by the warmth in the hands, feet, &c. The pain is mitigated, and by perseverance in the use of these means health is gradually restored."

Dr. Hale says, that during the whole course of the convalescence from *Spotted Fever*, until the cure was perfectly completed, most persons were subject to occasional attacks of pain and numbness, either together or separate.

Many other observers have recorded cases of Cerebro-Spinal Meningitis, which ended in paralysis, deafness and loss of vision; thus, out of ninety-seven cases reported by Dr. Githens, *deafness* existed during and after convalescence to a greater or less extent in sixteen cases; loss of memory was observed in seven cases, and purulent discharges from the ears during convalescence occurred in three cases.

I have observed paralysis of the lower extremities; paralysis of the bladder; paralysis of one or both upper extremities; dementia, insanity, blindness and deafness, to result from Cerebro-Spinal Meningitis.

Such results cannot be referred to the action of a distinct febrile poison.

CHAPTER IX.

HISTORICAL NOTES ON THE TREATMENT OF CEREBRO-SPINAL MENINGITIS. TABLE ILLUSTRATING THE NATURAL HISTORY AND DURATION OF CEREBRO-SPINAL MENINGITIS. RATIO OF MORTALITY. RELATIVE VALUE OF DIFFERENT REMEDIAL AGENTS. TESTIMONY OF VARIOUS PHYSICIANS AS TO THE VALUE OF BLOOD-LETTING, MERCURY, BLISTERS, CARBONATE OF POTASSA, HOT BATH, OPIUM, QUININE, COLD APPLICATIONS TO HEAD AND SPINE, AND OTHER REMEDIES.

WHILST there exists no want of theories and plans of treatment, and confidence in special remedies, unfortunately the attempts which have been made to urge the claims of conflicting systems, have availed but little in the accurate determination of those practical questions which involve the lives of a large portion of those afflicted with this sudden and fatal form of disease.

It is customary to dignify with the title *Extensive Experience*, the use of one or more remedies for a series of years amongst a number of patients, regardless of the fact, whether these remedies were selected as the result of education, or of accident and prejudice, or as the result of careful investigation and comparison of the relative effects and value of different modes of treatment.

The results are equally as bad, if not infinitely worse, when upon a few hurried and crude observations, a theory is erected, intended to express the pathology of disease, and a system of therapeutics invented to correspond with the notion of the nature of the disease. Much truth may be evolved from the use of a limited materia-medica; but a vast amount of error must necessarily follow from crude and hasty pathological speculations.

In medical science, as well as in sciences of more exact observation, no other method except that of strict induction from well observed facts, will result in the establishment of fixed and general principles, which will express with truth the operations of nature, and enable man to guide and direct them in fixed modes for the accomplishment of useful ends. Hypothetical discussions of the nature of disease, and of the action of remedies, apart from established facts, are worse than useless—they are positively injurious, in that they divert the mind from rigid experiment and from the careful observation of nature. In therapeutics, we need above all things, rigid observations on the effects of the different agents, on the duration, progress, effects and termination of particular diseases. In every inquiry in therapeutics, the physician should endeavor to determine.

1st. The natural progress of the disease when no remedies have been used: what is the natural history of the disease; what are the tendencies of the disease—to recovery or to death? The relative mortality to the total number of cases, and to other diseases; when recovery takes place, what are the antecedents and the immediate causes? The effects of variations of climate, of previous habits, of diet, of age, as well as the extent and severity of the inflammation or disease should be accurately noted; also the effects of various modes of diet and stimulation. The results of such investigations, will form a standard, by which the value of different remedies may be determined. Every conscientious physician desires to dispense with all needless remedies: and if it were possible to treat certain diseases by aliment alone, with more success than with drugs, it would be the manifest duty of the medical attendant to conform the treatment to the established course of nature.

2d. Whether the remedies used, diminish the rate of mortality in particular diseases, and thus contribute to the safety of the patient.

3d. Whether the remedies abridge the course of the disease.

4th. Whether they lessen the sufferings.

er they leave any injurious results.
odes in which the remedies assisted nature in the relief of disease.
er of physicians, thus acting in concert, even if each one experiments
s his experience with only a single remedy, and that his accustomed and
will be possible in the course of time, to determine with an approach
most efficacious remedies and modes of treatment.
pinal Meningitis we have to deal with a violent form of epidemic disease
nly, and affecting immense districts of country, the natural progress of
ly in the first period after its appearance in any locality, is towards

and rapid progress of the disease, is shown by the fact, that the most
rom the second to the fifth day, more than one-half dying then. If a
yond the sixth day, there is some chance of recovery, less than one sixth
er that time. The following tables illustrating the duration of disease,
by Dr. S. G. Webber, from the records of 164 cases published in various
ls:

E I. FATAL CASES.		TABLE II. DURATION OF RECOVERIES.		TABLE III. AGE AND POSITION.			
,	No. of Cases.	DURATION.	No. of Cases.	AGE.	Military	Civi'n.	TOTAL.
....	9	3 days..........	1	1 year..	...	2	2
....	6	4 days..........	2	1½ year..	...	1	1
....	18	5 days..........	2	2 years	...	2	2
....	17	7 days..........	3	3 years	...	2	2
....	16	10 days..........	1	4½ years	...	1	1
....	10	13 days..........	1	5½ years	...	1	1
....	4	14 days..........	3	6 years	...	4	4
....	1	16 days..........	1	7 years	...	3	3
....	4	17 days..........	1	8 years	...	2	2
....	2	20 days..........	1	9 years	...	2	2
....	1	21 days..........	3	10 years	...	4	4
....	1	23 days..........	2	11 years	...	4	4
....	1	26 days..........	1	12 years	...	1	1
....	1	28 days..........	2	14 years	1	2	3
....	2	30 days..........	1	15 years	4	3	7
....	1	36 days..........	1	16 years	3	3	6
....	1	37 days..........	1	17 years	4	1	5
....	1	40 days..........	1	18 years	8	2	10
....	1	48 days..........	1	19 years	11	6	17
....	1	50 days..........	1	20 years	3	2	5
....	1	58 days..........	1	21 years	5	...	5
....	12	Few days..........	1	22 years	3	...	3
....	...	6 weeks..........	2	23 years	2	...	2
....	...	18 weeks..........	1	25 years	2	...	2
....	...	10 weeks..........	2	26 years	...	2	2
....	...	4 months..........	2	27 years	1	...	1
....	...	5 months..........	1	28 years	2	...	2
....	...	Not mentioned..........	13	29 years	1	...	1
....	...	....	...	30 years	1	2	3
....	...	....	...	31 years	1	1	2
....	...	....	...	32 years	1	...	1
....	...	....	...	34-40 ys	3	2	5
....	...	....	...	42 years	...	1	1
....	...	....	...	46 years	1	2	3
....	...	....	...	68 years	...	1	1
....	...	....	...	not sta'd	11	37	48
				Total..	68	96	1

In regard to the period of recovery, it is not possible to give so precise information as in the case of death. It will be seen from the 2d table, that health may be regained at any period from the third to the tenth week.

Many of these cases from which these tables were constructed, were not reported up to the full restoration of health. Convalescence is usually slow and tedious, and as soon as that was fairly established, the record ends. This may perhaps account for the great difference in the length of the cases, some being recorded until health was entirely reëstablished, and others only until convalescence. Table 3d gives a comparative view of the ages of those who were attacked. This disease attacks most frequently youths and those in good health, the very young, the aged and the feeble being less liable to it; and it will be seen, from the table, that from 15 to 21 is the most exposed age, one-third of the cases having occurred during that period, and only five were attacked who were over forty. Males are more frequently attacked than females, the former furnishing in these statistics of Dr. Webber, 114 cases, the latter only 36; sex not mentioned, 14; 67 cases, however, were soldiers and midshipmen in the academy at Newport; deducting these, we have only 47 males, and the disproportion is not so marked, though still noticeable.

Hirsh reports that of 391 fatal cases, 359 were under 15 years. Niemeyer found that of 66 males, 20 died; of 60 females, 18 died; of 54 cases, from 1 to 5 years of age, 18 died; 40 cases, from 5 to 14 years, 9 died; 27 cases, from 15 to 23 years, 10 died; and in 5 cases, above 23 years, 1 died. The mortality, although uniformly appalling, is greatest at the beginning and diminishes as the epidemic progresses.

Among eighty-five cases recorded by Dr. Ames, there were twenty-two whites, viz: five years old and under, *one;* between five and ten, *two;* between ten and twenty, *eight;* between twenty and thirty, *three;* between forty and fifty, *two;* over fifty, *three.* Of the whites, ten were males and twelve females.

The blacks were sixty-three, viz: Under five years, *one;* between five and ten, *six;* between ten and twenty, *fifteen;* between twenty and thirty, *twenty-four;* between thirty and forty, *ten;* between forty and fifty, *five;* over fifty, *two.* Of the blacks, thirty-six were *males,* and twenty-seven *females.* In the cases observed by Dr. Ames, the mortality was confined to the malignant forms, and was about sixty (60) per cent. In an epidemic observed by Lefévre, four-fifths died at the commencement, and two-thirds towards the end of the epidemic. Of 366 cases analyzed by Dr. S. B. Hunt, the deaths were 243, and the recoveries 123, making the per centage of fatal cases 70 per cent.

The following mortality table was drawn up by Dr. J. S. Jewell from the monograph of Mr. Broussais:

Nancy	8	deaths in	28	cases	= 1 in 3.50
Le Mans	3	" "	9	"	= 1 in 3.00
Ancenis	4	" "	12	"	= 1 in 3.00
Mont Brison	16	" "	47	"	= 1 in 2.93
Caen	4	" "	10	"	= 1 in 1.25
Poitiers	8	" "	20	"	= 1 in 2.50
Versailles	111	" "	227	"	= 1 in 2.04
Metz	22	" "	40	"	= 1 in 1.81
Perpignan	28	" "	50	"	= 1 in 1.78
Strasbourg (Mil. Hosp.)	108	" "	184	"	= 1 in 1.70
Strasbourg (Inhabitants)	90	" "	150	"	= 1 in 1.66
Laval	44	" "	69	"	= 1 in 1.56
Colmar	5	" "	7	"	= 1 in 1.40
Bayonne	21	" "	28	"	= 1 in 1.33
Aigues Mort	120	" "	160	"	= 1 in 1.33

Thus, in 1035 cases, 592 terminated fatally, or 1 in 1.76.

Out of a total of 249 cases analyzed by Dr. S. G. Webber, death occurred in 147, and only 102 recovered. In the Sweedish epidemic, of 3051 persons attacked, 1387 died. Out of 161 cases treated in the Philadephia Blockley Hospital, during the months of December, 1866, January, February and March, 1867, 43, or a little more than one-fourth, died, and 31 were still under treatment at the time of the report. During the recent civil war, the disease was very fatal, in both the Federal and Confederate armies; it decimated one of the United States volunteer regiments in the West; in the first winter of its visitation at Memphis, there were no recoveries; in 35 cases reported by Dr. S. C Young, at Grenada, Miss., not one got well; Dr. Moses, of Mobile, did not witness a single recovery, and heard of but five; and the mortality throughout the Southern States during the war, has been variously estimated, from 60 to 80 per cent. In the Massachusetts epidemic of 1866, there were 278 cases and 170 deaths, or a mortality of a little over 61 per cent. Of 315 cases, selected from upwards of 500 cases, by Dr. J. Baxter Upham, which have been reported in Massachusetts since 1870, 173 recovered and 139 died, the ratio of mortality being 44.55 per cent., which was almost precisely the same as that of the 517 cases comprised in Dr. Upham's recent report to the State Board of Health. We are at a loss to know upon what data Dr. Alfred Stillé, of Philadelphia, founds the statement, that "while ten epidemics in various places, occurring between 1838 and 1848, presented an average mortality of 70 per cent., a similar number occurring during the decade from 1855 to 1865, give an average mortality of about 30 per cent; this remarkable fact would seem to indicate a gradual decline of power in the epidemic cause."

As far as the preceding data, gathered from various observers, extends, there is no ground for the adoption of the statement of Dr. Stillé.* On the contrary, there appears to be no abatement whatever in the fatality of Cerebro-Spinal Meningitis.

We have endeavored to show, in the Seventh Chapter, that the treatment of Cerebro-Spinal Meningitis, based upon the principles established by the investigation of the natural history and pathological anatomy of the disease, should, in the first stages, be directed to the arrest or modification of the congestion and acute inflammatory action in the cerebro-spinal nervous system.

The sudden onset and rapid progress of the disease demand the most prompt and energetic measures. The best means of modifying the congestion and acute inflammatory action of the cerebro-spinal nervous system, are general and local blood-letting, local counter-irritants, sinapisms and blisters, and the use of the warm water and hot air baths.

Blood-Letting.—As soon as the practitioner has convinced himself that the disease is Cerebro-Spinal Meningitis, the patient, as a general rule should be freely bled, (in the upright posture if possible), the blood being allowed to flow in a full stream until the patient feels faint and exhausted; from ten to twenty ounces of blood should be taken, the amount being regulated by the severity of the case, and the age, constitution and strength of the individual.

Cut-cups may also be freely applied to the temples, to the back of the head and neck, and along the region of the spine, and from two to eight ounces of blood should thus be withdrawn.

The bowels should be freely opened with Calomel, and if necessary with Croton Oil. If these measures fail to afford decided relief, the back of the head may be shaved and a blister applied over the region of the cerebellum, and back of the neck, and down the entire length of the spine. Over the spine this blister should not be wider than from one to one and a half inches.

After the evacuation of the bowels, Mercury may be given in small doses, combined with Quinine and Opium.

Free perspiration should be promoted from the very commencement of the disease, by conducting the vapor of hot water into the bed, so as to keep the body immersed in the vapor from the feet to the neck. The action of the skin and kidneys should still farther be promoted by copious drafts of some hot tea, as sage tea, in which Bi-Carbonate of Potassa has been dissolved, in the proportion of one drachm to the pint of tea.

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* Epidemic Meningitis, or Cerebro-Spinal Meningitis, by Alfred Stillé, M. D., etc. Phila., 1867, p. 72.

Cold cloths, wet with ice water, or bladders filled with ice, should be applied to the head.

When it is evident that the active inflammatory symptoms have subsided, the more energetic measures should be abandoned, and the strength supported by nutritious diet and stimulants judiciously employed. The contractions of the muscles of the neck and back, and the spasms may be moderated, and sleep promoted, by such remedies as Calabar Bean, Hydrate of Chloral and Chloroform.

Counter-irritation should be kept up along the back of the neck and spine by blisters or by Croton Oil.

In some cases Quinine in large doses has acted beneficially as a sedative.

In many cases the severe pain will necessitate the use of Opium. This remedy, or its alkaloid, morphia, may with benefit be combined with Hydrate of Chloral or Bromide of Potassium.

After the subsidence of the inflammatory symptoms, the convalescence will, in all cases be more or less tedious, in which there has been an extensive effusion of fibrinous or plastic lymph. During the transformation of portions of the deposit into fibrous tissue, and the absorption of other portions, the strength must be supported, and the more active depletory measures must be avoided altogether, or employed with caution, as they may retard the reparative process.

As it is customary at the present day to decry blood-letting in this and in almost every other disease, it is but just that we should examine the grounds upon which the merit of this remedy rests in Cerebro-Spinal Meningitis.

The Confederate Surgeons who bled not at all, or but seldom, and who used Quinine, Opium and Stimulants, lost almost every case of this disease.

Dr. Nathan Smith, in the Spotted Fever of his day, testifies, that "when to the universal torpor, which commenced with the disease, a high degree of excitement succeeded, blood-letting was practiced with good effect."

Dr. Joseph A. Gallup has left important testimony to the value of blood-letting in this disease; and his observations are especially worthy of consideration, as he adopted this remedy and used it freely, in opposition to the opinion of the profession and public. The entire observations of this intelligent physician "*on the Treatment or Methodus Medendi of Spotted Fever*," are worthy of careful study, at the present time, when the mass of the profession condemn blood-letting, without themselves having given the remedy a fair trial.

Some writers of considerable pretensions, who condemn bleeding in *toto*, in Cerebro-Spinal Meningitis, do so entirely upon theoretical grounds, as by their own confession, they have never used the remedy in a single case.

After illustrating his method of practice by cases, Dr. Gallup* proceeds thus to discuss the value of blood-letting:

> "It will not be maintained that blood-letting is always necessary or safe. It will only be insisted on that it is often necessary and sometimes indispensable. * * Support and equalize action when low, or depress and equalize action when high. Some cases I have met, where the most assiduous use has been made, from the beginning, of brandy, wine, essences and essential oils, cayenne, camphor, ether, etc., internally, to support, and to equalize action externally, warm bathing, blistering, frictions with red pepper and rum, moderate and long continued sweating, etc. By *equalizing*, it may be understood to divert the morbid action from the internal parts and important organs oppressed and agitated with pressure of blood and membranous inflammation, to the surface and extremities of the body. If excitement is kept up on the surface of the body, morbid action will spend itself partly there, and save the more noble internal parts from destruction. It is presumable that the pressure of the blood and peculiar inflammation of the membranes of the brain, diminish the nervous energy, and

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* Sketches of Epidemical Diseases, pp. 248-271.

may be a cause of weakening the heart, and the rest of the system. So, taking some blood oftimes actually gives strength to the action of the heart and system generally."

Dr. Gallup states, that in the epidemic of 1811, he bled from one-half to two-thirds of his patients, and that in not a single instance was there any reason to regret this practice.

Dr. Gallup recommended strongly, sweating, or the application of external heat, to restore warmth and vigor to the surface, and relieve the internal congestions; he gave a preference to the warm bath, but as this is often inconvenient, blankets dipped in water, and applied over the whole body may be substituted.

Dr. Gallup affirmed, that in his section of the country, an almost certain fatality had attended the use of Opium and Brandy in large quantities, and he recommended in their stead, hot infusions of aromatic herbs, seeds and roots. With reference to Blisters, Dr. Gallup says: "blistering ought to follow as soon as the patient has had warmth applied in the first instance. It is of great efficacy in promoting excitement on the surface; the absorption of a safe stimulus from the flies, is supposed useful, as also the mechanical irritation upon the skin, helps to increase sensibility in lethargic cases."

Dr. Gallup disapproves of the indiscriminate use of emetics, and directs that cathartics be used cautiously, as soon as the circumstances of the case will admit, as the evacuation they produce, and the translation of excitement from the head they effect, is often very useful in relieving the congestions in that part.

The results of this practice were most favorable, for we gather from the preceding statement, that Dr. Gallup lost only two patients out of eighty-one decided cases, giving a mortality of about one in forty, or 2.5 per cent.

Dr. James Mann, who served along the Canada border, as a Surgeon in the United States, during the war of 1812,–'14, in his "Medical Sketches of the Campaigns of 1812, '13, '14," has given an account of the "Epidemic Peripneumonia Notha," which prevailed both amongst the soldiers and the citizens, and was apparently due to the same causes, and was characterized by symptoms which in their sudden appearance, rapid progress, and fatal character, resembled those of the "Spotted fever," which it had succeeded.

The *peri-pneumonia notha* of that day occurred during, and subsequent to cold, damp, wet, changeable weather, and is described as making its first attack with symptoms of uncommon coldness and torpor, which pervaded the whole system, without those strong rigors observed in pleurisy, and intermittent fever, the heat of the body at the same time, to the touch, was much below the standard of health; during this state of torpor, an oppressed respiration with pain in the side supervened; the first stage of congestion and depression was followed by reaction, and in the stage of febrile excitement, the heat of the body was never much above the standard of health. The pulse during the cold stage was very small, and somewhat fuller than natural during the hot stage, but except in very robust constitutions, it was not what might be denominated as a hard full pulse. In many cases, the disease proved fatal in an incredibly short time, and apparently in the first stage, and in some instances, in less than twenty-four hours, after the first symptoms of indisposition supervened. Dr. Mann relates the case of a soldier, attached to the hospital as a nurse, who complained that he had taken cold, and that he felt an oppression at his breast; so little was his indisposition, that he went to the lake shore, distant sixty rods, returned with two buckets of water, flung himself on his bed, and died in six minutes, apparently in a state of suffocation. There were other instances of death almost as sudden. Upon inquiry, the patients said that they did not suffer from extreme pain, but from a weight upon the chest, an oppression from an inability to inhale the air, the lungs being so engorged as to be incapable of absorbing or transmitting through its membranes, the oxygen of the atmospheric air, and the poisonous carbonic acid gas of the blood. Post-mortem examinations revealed engorgements, congestions and inflammations of the lungs, even in those who had died in the first stages, before the establishment of the febrile stage.

The bronchiæ were charged with a mixture of blood and mucus. Where the disease had been of some duration, adhesions of the lungs to the subjacent parts were noticed; the spongy texture of this viscus was lost, while it assumed in some measure, the solid and compact state of the liver; it was sometimes covered with a yellowish glutinous, extravasated fluid, which adhered with some force to its surface. Dr. Mann describes a remarkable, pale, pink colored suffusion over the whole face, distinct from the usual febrile blush in the cheeks; the appearance was similar to the sudden flush color produced by sitting before a fire, after having been exposed to cold. This appearance was most conspicuous on persons having fair and light complexions. A cough supervened after the first twenty-four hours, in some instances, and when it was accompanied with an expectoration, the pain in the side abated; but if no expectoration accompanied the cough, all the dangerous symptoms were aggravated.

Dr. Mann has recorded several observations which illustrate the close relationship of this disease, with "*Spotted Fever;*" thus he states that during the cold stage, the patients suffered with pain throughout the muscles of the body:

> "And in four or five instances, this epidemic made its assault upon the head, which bleeding immediately relieved; upon inquiry I found there was here no complaint whatever within the chest. It was then prognosticated that in twenty-four hours, more or less, disease would exhibit itself on the lungs. This prediction was fulfilled in every instance when made. * *
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> In the campaign of 1814, there were a few cases of disease which assumed the form of spotted fever, in which the brain seemed to be the seat of disease; mental derangement having been the most alarming symptom, without any pneumonic affection. The progress of the symptoms was so rapid that no decisive mode of practice was adopted. All of them died, within the first twenty-four hours, two of the number within six hours.

Dr. Mann has left most clear and decided testimony to the inflammatory nature of the "*Pneumonia Notha, Pneumonia Typhoides, Malignant Pleurisy, Bilious Pneumonia,*" which he considered in all respects similar to the *Peri-pneumonia Notha*, described by John Bell and other old writers; and he has farther shown, that blood-letting was the most efficient and valuable remedy.

In his remarks upon the treatment of the disease, as it prevailed during the campaign of 1812, he says:

> "Without the employment of the lancet, other auxiliary remedies proved ineffectual. The bleeding should be small, and repeated, until the pulse becomes fuller and the heat of the body is increased above the healthy standard, when the patient may bear a larger quantity. The patient sometimes fainted with the loss of eight ounces of blood at the first, who subsequently was bled sixteen ounces, without any collapse of the vessels. A fortunate use of stimulants, in a solitary instance only, within my knowledge, proved successful, while their indiscriminate use induced a most deadly practice. Such was the practice in the army for a short period. Brandy, wine and soups, were the remedies administered in every form of these pulmonic affections. Prior to these potent stimulants, emetics, cathartics and blisters were employed. The lancet was prohibited under every form of this epidemic.
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> "It has been observed, the physicians, at the first appearance of this epidemic, doubted the propriety of bleeding. Their doubts were removed by the superior success which followed the use of the lancet, while stimulants proved fatal.
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> "This epidemic was considered by some typhoid, or asthenic. A typhus fever is always accompanied with a prostration of the strength and low delirium. Will a disease be considered typhus, when the patient is able to walk the room, and continue this exercise even a few minutes previous to death? Is that disease typhus, which is relieved by bleeding? This form of the disease, in some cases demanded as many ounces of blood in the course of the treatment as is often drawn from a person in severe pneumonia, accompanied with high degrees of heat, strong arterial action and acute pain. Yet, in this disease, it was inexpedient to take more than two, four, six or eight ounces at once. The above quantities were taken away every two, four or six hours, *pro re nata*; until permanent relief was procured. Sometimes after the first bleeding, the pulse became fuller, and the heat of the body increased. This favorable circumstance, however, did not usually follow until after the third or fourth bleeding."

Dr. Mann, in his account of the winter epidemic of 1815, 1816, reaffirms his views.*

Dr. Ames employed blood-letting in the beginning of the attack, frequently and boldly, without regard to the state of the circulation, in the congestive, as well as the inflammatory forms of Cerebro-Spinal Meningitis. The quantity taken at one bleeding, or at several, in quick succession, was sometimes very great,—on one occasion the quantity taken at a single bleeding was forty-eight, and on another, forty-four and a half ounces. In the greater number of cases, the entire quantity taken from adults in one day, varied from fourteen to forty ounces—in twenty-six cases the average was found to be thirty ounces. The value of this heroic employment of the lancet was most frequently observed in the inflammatory form, an improved state of the pulse, and relief of the cephalalgia, being the immediate consequence of the loss of blood. On the whole, Dr. Ames believed that prompt and free bleeding in the early stages of both the congestive and inflammatory forms was useful, in consequence of the time gained by it for other remedies, which Dr. Ames conceived to be more obviously beneficial.

Mercury, in the hands of Dr. Ames, employed to produce its constitutional effects, proved to be a more efficient remedy than blood-letting, both in the promptness and permanence of its beneficial influence. If not always effectual, Dr. Ames considered Mercury to be always safe, and the good obtained by it, to be more apparent, and quite as permanent as that from all other remedies. In a few instances, however, salivation induced early in the attack, and kept up for several days, failed altogether in producing any perceptible influence,—in some cases, time was not afforded to effect salivation, and occasionally, though rarely, the specific influence of the remedy could not be obtained.

Blisters to the upper portion of the spine, were found, in mild and grave cases, seldom to fail in removing, or greatly relieving the cephalalgia, even when bleeding had failed to do so. In the malignant varieties also, the relief afforded by them was very great. In the congestive forms, heat applied to the skin generally, mustard plasters and frictions with oil of turpentine, were frequently beneficial.

Carbonate of Potassa was employed by Dr. Ames, with apparent benefit, in several cases, and his experience with this remedy was such as to induce him to recommend it to the attention of the profession. It was given to children in doses of from three to five grains, and to adults in doses of from ten to fifteen grains, repeated every two hours. No case proved fatal in his practice, or, as far as he could learn, in that of either of his professional brethren, in which it was freely and continuously employed. But it is to be observed that, under any treatment, the mortality was confined to the malignant forms of the disease; that the remedy was given in but few cases of this kind, and that other remedies of the most energetic kind were also administered along with it. The powers of the remedy were exhibited in a much less equivocal manner, in the grave and mild varieties. In many cases in which there were no febrile symptoms, properly so-called present, the cephalalgia was speedily and permanently relieved, and in others its administration was followed by a prompt reduction of the arterial excitement, and the removal of intense cephalalgia, and other symptoms of head disease. In one chronic case of the grave variety, in which the patient was fast sinking into a state of dementia, convalescence began on the day that the medicine was first administered. This man had been bled, salivated and blistered without benefit.

Quinine was employed by Dr. Ames frequently in the grave variety, to which it seemed most applicable, and sometimes with partial success. When the disease was attended with a fever, which was regarded remittent, the meningitis appearing as if it were engrafted on a remittent fever, Quinine occasionally arrested the paroxysms, but more slowly, and with greater difficulty than in other fevers. In other varieties of

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* Medical Sketches of the Campaigns of 1812–'13–'14; to which are added Surgical Cases; etc.; also an Appendix, by James Mann, A. A. S., Hospital Surgeon of the Army. 1816. pp. ix, 16, 17, 34, 125, 127, 305–317.

Cerebro-Spinal Meningitis, Dr. Ames could not recommend this remedy; in such cases its use, if not hazardous, never afforded much encouragement.

Dr. Ames used *Emetics* but little, but frequently employed *Cathartics* as adjuvants, and to effect particular indications, but he did not rely upon them as curative remedies. In two instances, a free catharsis, induced by drastic medicine, was evidently prejudicial.

Opium was not considered by Ames as a safe remedy in the inflammatory malignant variety, nor of any use in the congestive malignant form; in the other varieties of the disease it was safe and valuable as an anodyne remedy.—New Orleans Med. and Surg. Jour., November, 1848, vol. v, No. iii, pp. 295–328; Am. Jour. Med. Sci., April, 1849, pp. 451–452.

Dr. Ames employed blood-letting much more freely than Dr. Gallup, and his success was not so marked. By a careful comparison of the testimony of these two observers, it would appear that comparatively small bleedings, repeated at short intervals, if necessary, are more beneficial than these large evacuations which may in the congestive cases, depress the forces below the point of reaction.

Dr. Toudes, who advocated blood-letting, says, that to deny absolutely the utility of bleeding, would be to fall into an exaggeration as false, as the unlimited confidence in the employment of that remedy; and notwithstanding the frequent inefficacy of bleedings in the epidemic which he witnessed, he nevertheless concludes, that they rendered more real service than other medicaments. In the observation of this physician, the local abstraction of blood in the early stages of the disease, was in a number of cases attended with good results, and followed by the happiest cures.

Casimir Broussais, considered bleeding as the only means of treatment during the early stages, likely to be attended with success; and Professor Forget strongly favored general and local depletion, considering the latter preferable; Matlot, Basseron, Cadis, Maillot and many other European physicians, have advocated and practiced free bleeding from the arm, and locally by leeches and cups.

Dr. Robert Burns, of Philadelphia, who employed both local and general blood-letting, reports most favorable results, viz: nine recoveries out of 12 cases. The following is his method of treatment.

> "The treatment pursued was the early abstraction of blood generally or locally, according to circumstances, to relieve the brain and spine. Stimulating frictions to the whole spinal column and extremities. Warmth to the feet, with sinapisms to different parts, to cause counter-irritation. Blisters sometimes, but seldom necessary stimulants. Diaphoretics when feverish. The liver and bowels steadily acted on by mercurial purgatives at night, and Castor Oil next morning, and as soon as the violence of the symptoms abated, Quinia freely administered to the amount of eight or ten grains per day, for the first three or four days; this however, to be varied according to circumstances. The nutriment, chiefly beef tea or essence, barley, gruel, sago, and such other articles of a similar kind as best suited the disease, or inclination of the patient."

Mr. Burns applied leeches freely to the back of the neck and temples. Dr. E. Greene, of Bellefonte, Pa., has illustrated the value of blood-letting in a successful case reported in the Philadelphia Medical Reporter, May 7th, 1864, pp. 277, 278.

We will examine briefly, in the next place, the testimony of some of the principal American authors, who have opposed blood-letting in Cerebro-Spinal Meningitis.

Dr. Hale considered the disease as a fever, adynamic in its character, characterized by great debility and prostration of strength:

> "The strength was not only oppressed by the impulse of disease, but it was rapidly exhausted; to adopt the comparison of Fordyce, the spring was not only overpowered, so as to prevent its action, but its elasticity speedily vanished under the weight which pressed upon it."

Acting on this hypothesis, Dr. Hale did not employ venesection in a single case, nor did he see any case in which it had been employed. He says:

> "I was deterred from publishing it, by the great tendency to debility which I witnessed in the disease, as well as by the reports which I have heard of the disastrous effects, which were said to have followed its use in other places." And strangely enough, he adds: "The foundation of these reports, or the accuracy with which they were related, it does not come within my plan to examine here."

Dr. Hale, thus defines in general terms his mode of treatment.

> "The first and leading object, always was to restore and continue in force the functions of the skin. The second which was hardly less important, was to support the strength of the patient. The remainder of the cure was effected by removing the great variety of occasional symptoms which occurred. The means for accomplishing the two first objects, were pretty uniformly the same in the several cases. But for the last, the whole materia-medica presented a field hardly enough variegated for the complicated and perpetually changing evils to be removed." * *
>
> "The treatment here described, was not such a course of indiscriminate exhibition of stimulants, as those who disapprove of blood-letting and other copious evacuations in this epidemic are supposed to have pursued, stimulants, it is true, were frequently administered, and in some cases very freely; but they were not prescribed without a rigid attention to the symptoms which indicated, or which at least appeared to indicate them. The principal reliance for the removal of the fever was upon a vigorous course of alteratives, aided by the applicationof external warmth and moisture, and stimulants were chiefly given to prevent and remove the prostration and debility which the fever generally produced." pp. 244, iii, 126–220.

The epidemic treated by Dr. Hale was comparatively mild, and we are unable to determine with precision the ratio of mortality, but from the statement of the author the results of his treatment were favorable, and he alludes to only seven fatal cases in his practice.

Dr. Thomas Miner, held that:

> "By an energetic exciting treatment at its access, this disease is frequently broken up within twenty-four hours. When we fail in producing a revolution, and only make such an impression as to moderate the violence of the symptoms it usually continues seven, or in some instances fourteen days, requiring the same course of practice according to the urgency of the symptoms, as is demanded in the supporting stage of Typhus."—*Essays on Fevers*, p. 119.

According to Dr. Miner, "*Spotted Fever*" has "its seat and throne in the brain," and belongs "nosologically to the passive phlegmasiæ;" and "no foreign author," he confidently believed had "ever described this disease." The work of Dr. Miner is absolutely devoid of all data, by which any judgment might be formed, as to the relative merits of his plan of treatment. To illustrate his views he records only one case, and that a fatal one; and yet this writer has been quoted by Dr. Alfred Stillé, as an "*authority*" against blood-letting. Dr. Miner entered into no discussion whatever, as to the merits or demerits of blood-letting in this disease, but simply advocated a stimulant and supporting plan of treatment.

The Committee of the Massachusetts Medical Society, charged with the inquiry into the causes and history and modes of treatment of the epidemic of 1810, did not advocate bleeding, as it was generally thought to be injurious; they recommended, however, sweating by both internal and external means, and the judicious use of stimulants as cordials and opium.

Dr. W. W. Gerhard,* of Phildelphia, who held, as we have more fully shown elsewhere a doctrine similar to that advanced by Dr. Hale and others, more than half a century ago, viz: that "the disease belongs to the same class, as other continued fevers or exanthemata, and is strictly a blood disorder unconnected with any structural lesion," in like manner and upon the same grounds condemns blood-letting, although according to his own admission, he had "*never practiced nor advised blood-letting in any case.*" Dr. Gerhard's plan of treatment was evidently founded upon his preconceived hypothesis of the nature of the disease, and not upon the results of actual experiment and comparison of the different modes of treatment.

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*Trans. Col. Phys. Philad., 1864, pp. 48, 49.

Dr. Gerhard does not appear to have had any great success with his mode of treatment for, of twenty cases alluded to in his paper, ten, or exactly one-half (50 per cent.) died; and in speaking of the success of the physicians of Philadelphia, in the treatment of the epidemic, he states, "that at least one case out of three or four has been fatal," and, "at first, the mortality was much greater in several localities."

Dr. Geo. B. Wood, of Philadelphia, whilst expressing a more comprehensive theory of the nature of the disease, in like manner appears to base his objections to blood-letting exclusively upon hypothetical reasoning, and not upon actual experience with the relative value of this remedy.

Dr. Wood divides the disease into two varieties, which he affirms are distinguishable by the predominance respectively of the features which have, in different places, given rise to the names of Spotted Fever, and Cerebro-Spinal Meningitis. The difference consists, in his opinion, in the more decided exhibition, in the one, of the characters of a blood disease, as evinced by the early appearance of petechiæ, and in the other, of the symptoms of inflammation of the investing membranes of the brain and spinal marrow. He admits that the two varieties are separated by no precise line, as they run together by insensible shades; but in their extremes they are strikingly different.

After careful examination of the entire article upon *Petechial or Spotted Fever*, in the work of the learned Dr. Wood, I have failed to find a single case, or practical observation, illustrating, or supporting his system of treatment, which might, with truth, be styled the *expectant* plan of treating Cerebro-Spinal Meningitis.

The experience of certain European physicians, with reference to the value of blood-letting, is more decided, and apparently based upon more reliable data; and it must be confessed that the weight of this testimony is adverse to the indiscriminate employment of this remedy. De Renzi, Tourdes, Mottet, Lefévre, Faure, Besseron, Corbin, Maillot, and Laveran, have recorded observations illustrating the uncertainty of this as well as of all other remedies in the treatment of this disease. Dr. N. S. Davis, of Chicago, claims to have had good success, in the epidemic which prevailed in Chicago, in 1872, by the employment of Calabar Bean and Ergot. A teaspoonful of a mixture composed of one and a half fluidounces of Tincture of Calabar Bean, and two and a half fluidounces of the fluid Extract of Ergot, were given every two hours, by Professor Davis.

Cantharides, in the hands of Professor Allen, of the Rush Medical College of Chicago, is said to have yielded good results in the early stages, and in cases exhibiting marked depression, even Strychnia has found advocates in Drs. Noble, Wales and Palmer; while the evidence as to the value of large doses of Quinia, combined with Opium is conflicting. More recently Bromide of Potassium and Chloral Hydrate have found advocates.

Dr. Alfred Stillé, has well said, that the difficulties involved in the questions which have hitherto been discussed, and which refer exclusively to the history, phenomena, and nature of epidemic meningitis, are trifling in comparison with those that relate to the cure of the disease; these are partly inherent in the general subject of therapeutics, in which no problem whatever is susceptible of a categorical and permanent solution; they depend still more upon the epidemic nature of the disease which gives a great diversity of type.

> "These difficulties are further multiplied by occurring in a disease which stands alone in all other respects; whose causes, phenomena and lesions, in a word, whose laws are specific, and whose varieties of type are as infinite as can be formed by the combination, in constantly varying proportion, of a special disease of the blood deranging the molecular actions of the economy, and an inflammation of the Cerebro-Spinal Meninges, and even of the substance itself of the great nervous centres. These reasons are sufficient to account for the divergent, and often opposite methods of treatment which have been adopted and recommended by physicians of equal sagacity, at different times and places."—Epidemic Meningitis, etc., p. 134.

Dr. J. Baxter Upham, in his recent paper on the late epidemic of Cerebro-Spinal

d before the Massachusetts Medical Society, June 2d, 1874, has forcibly
state of doubt, hesitation and absolute obscurity, which characterizes the
e present day.

however, notwithstanding the doubt and uncertainty, disclosed in the
lassachusetts Board of Health, from two hundred physicians, represent-
en towns and cities, and containing the data, more or less complete, of
hundred cases of the disease, and giving a mortality of nearly one-
eases reported, concludes that "*something can be accomplished in the*
nt." Thus he concludes his article with the following practical observa-
of which is similar to that of the views of Drs. Wood and Gerhard:

> iind the essential element of the disease, a morbid poison, acting primarily
> uid and affecting secondarily and rapidly the meninges of the brain and spinal
> ially giving rise to symptoms and phenomena which simulate while they are
> h inflammatory action in these parts, and consequent exhaustion of the vital
> t perversion of the nerve force, as manifested in the irregular action of the
> d breathing, the restlessness and jactitation and extreme sensitiveness of the
> ering also the material lesions which are so generally revealed on *post-mortem*
> ndications for a rational treatment, should be these:—
> and the strength.
> at the tendency to congestion of the brain and spinal cord.
> ate the intense pain.
> the nervous excitement
> sh and support the system till the exuded morbid products can be removed
> fices of nature, and to minister, in the meanwhile, by all the ways at hand,
> d relief of the patient."—Boston Medical and Surgical Journal, September

ndeavored to present a general view of the various modes of treatment,
n proposed and practiced with the hope, that the record will prove of
; and that whilst serving to direct the attention of physicians to the diffi-
bject, and the doubt and obscurity which involve the therapeutics of this
isease, at the same time it may excite renewed interest in its thorough

tics of Cerebro-Spinal Meningitis will be advanced in the future, by
vestigations of the symptoms, (pulse, respiration, Temperature, nervous
henomena, etc.,) Chemistry, (composition and changes at various stages
of the Blood, Urine and various secretions and excretions), Pathology
s, in various countries and under various conditions of climate, soil and
ill permit of careful comparison and analysis.

CLINICAL OBSERVATIONS

ON

CERTAIN DISEASES OF THE LYMPHATIC

AND

CIRCULATORY SYSTEMS,

AND OF THE

LIVER AND KIDNEYS:

ILLUSTRATING THE

RELATIONS OF DROPSY TO VARIOUS DISEASES.

CLINICAL OBSERVATIONS ON CERTAIN DISEASES OF THE LYMPHATHIC AND CIRCULATORY SYSTEMS, AND OF THE LIVER AND KIDNEYS, ILLUSTRATING THE RELATIONS OF DROPSY TO VARIOUS DISEASES.

CHAPTER X.

OBSERVATIONS ON OSMOSIS. PRELIMINARY REMARKS CONCERNING THE OBJECTS OF THE INVESTIGATION. DEFINITION OF THE TERM DROPSY. OSMOSIS, ENDOSMOSIS, EXOSMOSIS, IMBIBITION, CAPILLARY ATTRACTION, ABSORPTION, DIFFUSION. EXPERIMENTS ON LIVING ANIMALS, ILLUSTRATING THE PHENOMENA OF OSMOSIS AND THE ABSORPTION AND ACTION OF SALINE PURGATIVES.

PRELIMINARY REMARKS CONCERNING THE OBJECTS OF THE INVESTIGATION.

Useful results in clinical instruction, may sometimes be obtained, by grouping together the more important facts relating to some grave and striking symptom, and by investigating the relations of this symptom to a large number of diseases. No symptom is more striking or more uniformly grave, than dropsy, and as the practitioner is often tempted to treat this distressing complication of a number of dissimilar diseases, upon a uniform plan of routine practice, it was thought important to demonstrate its connection with various diseased states. We are thus enabled to group together many of the most interesting cases of disease of the heart and circulatory system, and of the abdominal organs.

Whilst the cases recorded are grouped, so as to illustrate one of the most striking symptoms, common to a number of diseased states, at the same time, the facts and commentaries will serve to illustrate many points in special diseases: and whilst we are thus taught by experience, that oftimes no small difficulty is encountered, in determining to which of its many sources, a particular symptom, common to many diseases, should be referred; at the same time we are impressed with the absolute necessity of acquiring definite notions of the special disease, or condition on which the symptom depends.

It has been proposed to erase dropsy from the list of substantive diseases, and to place it in the catalogue of mere symptoms, and connect it with the original maladies upon which the effusions or accumulations of fluid depend. It would appear however, that it is destined to be considered as a special disease or diseased state by systematic writers, from the great difficulty experienced in many cases, of determining during the life of the patient, the lesions upon which it depends, and also because to the practitioner, dropsy is in all cases, something more than an effect or symptom of disease, as the dropsical effusion may become the cause of other and most distressing symptoms, causing, in some cases, extensive destruction of tissue, and in others, embarrassing by its pressure, important functions, and even extinguishing life; and finally removal of the dropsy, even when the original cause remains, may restore the to a state of comparative comfort and health.

We do not propose to enter into an exhaustive consideration of all the dropsy, but desire chiefly to examine the causes which have been illustrated by actually observed and recorded in the practice of the author.

It may perhaps add something to the accuracy of the succeeding discussions, to recall the attention to the definition of certain terms employed by tematic writers.

Dropsy, (formerly written hydropsy, whence by contraction, *dropsy*): accumulation of watery or serous fluid in the areolar tissue or serous cavities, either from increased exhalation, or from diminished absorption, each of which tions depend upon antecedent states of disease. When limited to one part, the *œdema* is employed, denoting swelling produced by the accumulation of serous the interstices of the areolar texture, which swelling is soft, yields under the preserves the impression for some time, and is pale and without pain. dropsy is extensive, the term *anasarca* is employed, and by some writers as with *general* dropsy. When limited to the peritoneum, it is called abdominal or *ascites*. Specific names are also applied, as descriptive of the sack, tissue or involved; as when it affects the pleura, *hydrothorax*, or dropsy of the chest; pericardium, *hydropericarditis, or dropsy of the heart*, when the arachnoid, *cephalus, or dropsy of the brain;* when the spine, *hydrorachitis;* when the hydrocele; when the uterus, *hydrometra;* dropsy dependent upon disease of the *hydrops hepaticus;* dropsy dependent upon disease of the kidney, *hydrops renalis.*

During life, there is a continuous circulation of the fluids and elements of not only by means of the heart and blood-vessels, but interstitially by a slower of osmosis through the walls of the blood-vessels and absorbents, and through the vidual constituents, the cells and fibres of the various organs and tissues. not so rapid nor so manifest to the senses as the greater circulation, the constant slow interchange of the fluids of the body is of great if not of equal importance. fluid constantly secreted by the closed cavaties and interstitial tissues, is as re-absorbed into the circulation: when, therefore, the serous fluid accumulates in tissues or cavities, without active inflammation, either the quantity of fluid has been abnormally increased, without a corresponding increase in the absorption, or it may be with an actual diminution of absorption,—or else the has continued the same as in health, whilst the absorption has been diminished.

OSMOSIS, (ENDOSMOSIS, EXOSMOSIS, IMBIBITION, CAPILLARY ATTRACTION, TION, DIFFUSION).

It has been held by physiologists, that the lymphatic as well as the blood- system, never terminate by independent extremities, but everywhere present a tinuous network; and the teachings of both anatomy and physiology, up to a atively recent period, appeared to establish the conclusion, that absorption is effected by the capillary attraction dependent upon *porosity*, which characterises as well as inanimate matter. If it be granted that the whole vascular system, exception perhaps, of that of the spleen, the medulla of bone, and some other tissues, is lined with a continuous membrane, it follows that no substance can the blood-vessels, excepting in a state of solution, and that the process of absorption is one either of mechanical filtration, or of osmosis, including term that of capillary attraction and diffusion. The fact that the pressure vascular system, is everywhere greater than the pressure outside, renders it that venous absorption is something more than mere filtration. The Stricker and others have shown that capillary vessels are composed of a contoured, dull membrane, in which oval nuclei are imbedded, at tolerably vals. The parietes of these tubes are therefore not structureless; but granules are distributed through the capillary wall in a stellate manner, and in its general appearance, it closely resembles protoplasm. It has not been clearly proved that the small, irregularly shaped, dark, sharply defined spaces, observed within as well as between the cells, after treatment of the capillary wall, with Nitrate of Silver, are actually spaces (Stomata of Conheim). In order to understand the passage of the colorless corpuscles through the vascular walls, in the process of inflammation, it is not necessary to admit the existence of coarse spaces or openings (*stomata*), provided the capillary walls be regarded as composed of a soft material having the properties of protoplasm, and forming an elastic and permeable membrane. If the openings in the capillary wall, were really coarse, coloring particles of large size would pass through the vascular wall in various regions; but this never occurs. The colorless corpuscles on the other hand, by reason of their softness and elasticity and living properties, not only accommodate themselves to the fine invisible pores of the vascular membrane, but also exert what may be termed a digestive and assimilative action upon the capillary wall, similar to that possessed by certain animals of a simple construction. The escape of the colorless corpuscle in inflammation must not therefore be regarded as a simply passive process, like the filtration of a colloid substance, to which it was likened in the first instance by Hering; for this phenomenon can be influenced in the most various modes by the contractility of the cells: everything, in fact, which favors or checks the active motility and vital endowments of the colorless corpuscles influences their extravasation.

The serous or tissue fluid, with which, in consequence of the pressure under which the blood courses through the vessels of the several organs of the body, the tissues are constantly permeated, requires constant renewal. Without a constant and rapid exchange of this serous fluid, which to a great extent furnishes materials requisite for the tissues and the preparation of the secretions, the composition of the various tissue elements around which it plays, would be quickly and permanently altered. As soon as the pressure of the fluid in the tissues, approximates that under which the blood moves in the vessels, the passage of fresh serous fluid from the blood into the tissues would cease. The constant escape of the serous fluid from the tissues, is provided for, by means of the lymph vessels, which form a peculiar system, the rootlets of which are distributed through the tissues, and which is related to the blood-vessels, in that it indirectly withdraws from them the fluid they contain, and ultimately returns that fluid to the blood-vessels by its terminal trunks.

It has thus been shown by physiologists, that the origin of the lymphatic system is in relation with the capillary vessels in which the blood moves under a considerable pressure; and that its termination on the other hand, communicates with the chief venous trunks, and consequently with those parts of the vascular system in which the blood pressure descends to its minimum amount, and in fact, almost to zero. The conclusion has hence been drawn, that the difference in the amount of these two pressures, constitutes an essential factor in the production of the movement of the lymph: so that the greater the difference, the more rapid is the movement: the lymphatic vascular system therefore borrows its contents, as well as the impulsive force under which they move, from the blood-vessel system; and in so far it may be regarded as an appendage of, or as an accessory closed system to, the blood vascular apparatus. It is no longer a matter of doubt, that the *capillary lymphatics* are lined by a single layer of flattened epithelium, and that they also possess a special membrane, though not completely homogenous and structureless as was formerly maintained, nor entirely closed. In some lymphatics, openings of appreciable size, are known to occur, through which even during life, small bodies may be absorbed into the interior of the tube. The openings or stomata in the lymphatics, were first demonstrated by Professor F. V. Recklinghausen, in the central tendon of the diaphragm. If milk, blood or fluids, which have insoluble substances in suspension, be injected into the peritoneal cavity of mammals, a beautiful injection of the network of lymphatics of the central tendon of the diaphragm may be obtained. It has been shown by various experiments, that the openings by which solid matters gain entrance into the lymphatics are roundish, sometimes quite round, and represent, as is clearly shown by subsequent staining with Nitrate of Silver, spaces between the epithelial cells.

They usually lead perpendicularly into the lymphatic vessels, over which they are immediately placed, but sometimes they are situated somewhat obliquely towards the margin of the vessel, or they may even be as far distant as a semi-diameter of the vessel, in which case there is an oblique canal leading to the latter. The openings (stomata) never exceed the size of an epithelial cell. From the experiments of Recklinghausen, Schwigger-Seidel, Dogiel, and Dybskowsky, it is rendered probable, that analogous formations, will be found in the pericardium and in the arachnoid membrane of the brain, and all serous cavities possess a very intimate and direct connection with the lymphatic system.

From such facts, the inference has been drawn, that whereas it is the function of the blood-vessels to absorb substances which are soluble and diffusible, those which are incapable of diffusion are taken up by the lymphatics.

It is evident, also, that capillary action is not the sole cause of absorption in living tissues; it simply causes or permits the entrance of fluids through the interstices of the tissues, and cannot produce motion beyond the limits of the solid body, with which it is connected, and the phenomenon of Osmosis, (Endosmosis, Exosmosis, Absorption,) is dependent also upon certain conditions, as the physical and chemical relations of the fluids to the interposed membrane, and to each other. This increased flow in one direction or the other, is determined not alone by the differences of densities in the opposite fluids, but also by their chemical relations to the interposed membrane, and by the relative diffusive powers of the salts which they respectively contain. Upon such facts rest the power of the physiologist and physician, to increase or diminish Osmosis in living tissues, by the employment of certain remedial agents.

The phenomenon of Osmosis, forms as it were, an essential and primary act or condition of all vegetable and animal existence, for it is coeval with all vital manifestations, and endures throughout the existence and action of all the component parts of each living structure, and is absolutely essential to the acts of nutrition, secretion and growth. And it may be shown by actual experiment and calculation, that the circulation of the fluids, through the various organs and tissues, by the comparatively slow process of *Osmosis*, is as essential to the manifestation of vital phenomena, as the more evident and rapid circulation of the blood in the higher animals. The life of the more simple animals, like that of the individual cells and morphological elements, composing the higher animals, is maintained, and the distribution of the elements of structure, accomplished by the physical process of Osmosis.

It is not my purpose to enter into an elaborate consideration of this subject, nor to dwell upon the valuable observations and experiments of the Abbe Nollet, who in 1748, directed attention to the passage of various liquids through animal membranes, of H. Dutrochet,[1] Carlo Matteucci,[2] Justus Liebig,[3] Julius Vogel,[4] Professor Thomas Graham,[5] and others: I desire simply to record the results of some experiments which I devised and executed with the design of illustrating certain physiological and therapeutical principles.[6]

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[1] De l'Endosmose des Acides, Memoire lu à l'Académie des Sciences le 19 Octobre, Encyclopædia of Anatomy and Physiology, by R. B. Todd, M. D., London, 1837.

[2] Lectures on the Physical Phenomena of Living Beings: Trans. under the Superintendence of Jonathan Pareira, M. D. etc.

[3] Researches on the Chemistry of Food, and the motion of the Juices in the Animal Body.

[4] Chemical Reports and Memoirs of the Cavendish Society, London, 1848.

[5] Phil. Trans., 1850–1861. Elements of Inorganic Chemistry.

[6] Abstract of Experiments on the Physical Influences exerted by Living Organic and Inorganic Membranes upon Chemical Substances in Solution passing through them by Endosmosis, by Joseph Jones, A. B., Student of Medicine in the University of Pennsylvania before the Academy of Natural Sciences, Philadelphia, October, 1854. Am. Jour. Sciences, April, 1855. Experimental Investigations, instituted with a view to ascert

Experiments on Living Animals, showing that their Membranes exert a Physical Influence capable of changing the molecular arrangement of Chemical Substances in solution, passing through them by Endosmose.

Experiments 310–318: I immersed the belly and lower extremities of a large spring-frog, in a strong solution of the chloride of calcium, and allowed it to remain for an hour; then washing it carefully with water, immersed its lower extremities in a strong solution of the oxalate of ammonia. It remained in this solution for one hour, when it was again carefully washed and placed in the solution of the chloride of calcium, where it remained for a similar length of time. Finally it was removed from this, back to the solution of the oxalate of ammonia.

During the course of the experiment, which lasted four hours, the frog gradually became weaker and more inactive, and finally died in the solution of the oxalate of ammonia in which it was last placed. The specific gravity of the solution of the oxalate of ammonia was much less than that of the chloride of calcium, consequently the object in moving the frog from one solution to another, was to obtain as large a deposit of the oxalate of lime within its blood-vessels and tissues as possible, by promoting the actions of imbibition, endosmose, and exosmose.

As a general rule, the rapidity of the action of endosmose is proportional to the difference of the densities of the exterior and interior fluids. The effects of this action, or rather of the membranes, upon the chemical substances passing through, will be manifested by the change of physical form exhibited by the precipitate of the oxalate of lime.

Immediately after the frog had been removed from the solution of the oxalate of ammonia an incision was made below and to the sides of its sternum, into the cavity of the thorax and abdomen. The heart was found still pulsating. The blood-vessels beneath the skin, upon the surface of the stomach and intestines, in the muscular fold of the peritoneum, and between the kidneys, appeared thoroughly injected with blood, as if the animal had died of violent inflammation of all these parts.

The blood from the heart and lungs was first examined under the microscope, in which, with a magnifying power of 210 diameters, were seen innumerable minute cubical particles, floating amongst the large elliptical blood corpuscles. In the fibrous tissue between the epidermis and pectoralis major muscle, square plates, cubical crystals, and parallelograms were seen, together with minute particles, the largest of which appeared to be cubes.

The mesenteric fold of the peritoneum contained the same equilateral, equiangular plates, and cubical crystals. In the fascia of the thigh, besides numbers of these, there appeared, also, beautiful octohedral crystals of the oxalate of lime, similar in all respects to those formed when the intestines of a raccoon (*Procyon lotor*) were filled with a solution of the chloride of calcium, and immersed in a solution of the oxalate of ammonia.

When the eggs of the frog were mashed, and their contents spread out on a glass slide and examined under the microscope, they contained multitudes of equiangular plates, and cubical crystals of the oxalate of lime. It is probable that the exterior fluids passed through the anus and cloaca into the oviducts and ovaries, and finally by endosmose into the eggs themselves.

In the fibrous tissue of the walls of the abdomen, in addition to the cubes and octohedra, and equilateral plates, there appeared, also, delicately formed dumb-bell and ellipsoidal crystals.

When the plantar fascia of the foot was cut through, from the incision flowed a fluid resembling the liquor sanguinis mixed with a little blood, which, under a magnifying power of 210 diameters, contained beautiful octohedral and dumb-bell crystals of the oxalate of lime.

This experiment was repeated, with slight variations as to the length of the time and the density of the fluids, and in every instance, without any exception, the results were the same.

In one instance, the deposit formed within the blood and tissues of the frog assumed the form of delicate dumb-bell and cruciform crystals of the oxalate of lime. In another experiment the blood from the ventricle of the heart contained large and perfectly formed octohedra, with a few dumb-bell crystals, while the various tissues and muscles contained chiefly delicately formed dumb-bell crystals, and the aqueous humour of the eye contained octohedral, and comparatively large acicular crystals.

We see, then, by these microscopical examinations, that the oxalate of lime has assumed forms different in all respects from those of the precipitate thrown down, when solutions of the chloride of calcium and oxalate of ammonia are brought into immediate contact. The

Action of Saline Solutions of different densities upon Living Animals, and also the Reciprocal Action, through Dead Animal Membranes of Serum, Water and Saline Solutions, by Joseph Jones, Student of Medicine, University of Pennsylvania. Am. Jour., Med. Sciences, Jan., 1856.

precipitate thus formed consists of minute irregular granules. What has changed the physical form of this deposit? It has been accomplished, without doubt, by the action of the membranes upon the chemical substances in solution passing through them.

Experiments on the Physical Influence exerted by Mucous Membranes, removed from all vitality, on chemical substances in solution passing through them.

Experiments 319–372: I filled the intestine of a raccoon (*Procyon lotor*) with a solution of the chloride of calcium, whose specific gravity was 1031, and immersed in it a solution of the oxalate of ammonia, having a specific gravity of 1007. In the course of an hour the exterior fluids became cloudy, with a white precipitate of the oxalate of lime. At the end of two days, a copious white deposit had settled to the bottom of the jar, which, under a magnifying power of 210 diameters, presented the appearance of innumerable acicular, rectangular, and irregular particles, often conglomerated together in great numbers, forming miniature representations of plants with their branches and leaves.

Specific gravity of exterior fluid 1005.

The interior fluid was next examined, the intestine having been punctured and its contents carefully removed.

Specific gravity of interior fluid 1003.

This marked change of its specific gravity from 1031 to 1003, shows that a free interchange of the fluids must have taken place. The slight change in the exterior fluid, of 1007 to 1005, is readily explained, when we consider the fact, that the exterior measured 12, whilst the interior was only 4 fluidounces.

Within the intestines but a small deposit had taken place, in comparison with that of the exterior fluid. Under the microscope this presented a magnificent crystalline appearance, differing wholly from that of the exterior fluids, and also from that formed when solutions of the chlorides of calcium and oxalate of ammonia are brought into immediate contact.

Amongst the crystals there were no less than seven well defined regularly formed varieties. We recognize the octohedral and dumb-bell crystals, as the forms in which the oxalate of lime almost invariably occurs in the urine, not only of man, but also of other animals, and even in that of birds.

Does not this experiment indicate that the peculiar forms of the oxalate of lime, occurring in urine, may be the result of the physical action of the basement membrane of the tubuli uriniferi and its secretory cells?

The tissues of the intestine were next examined.

The cellular tissue was not equally injected; in some places there was scarcely any, while in others there was a very abundant deposit.

In all places the mucous membrane appeared free from any deposit of the oxalate of lime. It was found difficult, however, to decide this question by the microscope, on account of the difficulty of separating the fibrous tissue completely, in which occurred a copious crystalline deposit.

This is not the only instance; out of numerous examples, we will select the following:

When the bladder of a raccoon (*Procyon lotor*) was filled with a solution of the bichloride of mercury, and immersed in a solution of the iodide of potassium, a brilliant red crystalline deposit of the biniodide of Mercury took place upon the exterior, whilst upon the interior a light yellow mass of lozenge-shaped crystals of the protiodide of mercury was precipitated. In this case also the mucous membrane appeared free from any deposit.

When the intestines of a raccoon were filled with a solution of the acetate of lead, and immersed in a solution of the bichromate of potassa, the deposit upon the exterior consisted of innumerable small, irregular granules, while that upon the interior consisted of beautiful, stellate crystals.

When a sheep's bladder was filled with a solution of the oxalate of ammonia, and immersed in a solution of the chloride of calcium, no deposit took place in the exterior fluid, whilst a precipitate of the oxalate of lime fell in the interior fluid.

Within the muscular and fibrous coats of the bladder this deposit presented the same appearance. The fact that solutions of certain chemical substances will pass through a membrane in one direction, but not in another, might be illustrated by many examples.

The stomach of a raccoon was filled with a solution of the bichromate of potassa, and immersed in a solution of the acetate of lead; a copious deposit of the chromate of lead took place in the exterior fluid, whilst none whatever occurred in the interior; it retained its natural color and appearance. The results were in all respects the same when the intestines of this animal were treated in a similar manner.

When the stomach was treated in this manner, a deposit took place only upon the interior. When the œsophagus of a large rattlesnake (*Crotalus Adamanteus*), was treated in a similar way, only a small deposit occurred in the exterior fluid.

I filled the stomach of a raccoon, and a portion of the intestines of a large rattlesnake with a solution of the iodide of potassium, and immersed them in a solution of the bichloride of mercury; in both cases, a copious deposit occurred upon the exterior, whilst little or no precipitate fell in the interior fluid.

These facts are due to one of two causes. Either certain chemical substances in solution exert an influence upon mucous membranes, changing their minute anatomical structure, and thus destroying their power of carrying on the physical phenomena of endosmose and exosmose; or else mucous membranes possess a power of choice, as it were, dependent upon their physical constitution, allowing one fluid to pass through in one direction, but not another fluid, holding a different chemical substance in solution, in an opposite direction. When a portion of the small intestine of a sheep was filled with a solution of the nitrate of lime, and immersed in a solution of the oxalate of ammonia, a copious precipitate of the oxalate of lime took place in the exterior fluid, which, under a magnifying power of 210 diameters, was found to consist of innumerable octohedral crystals of different sizes, also a few dumb-bell crystals.

In the exterior deposit the octohedra were about one hundred times more numerous than the dumb-bell crystals.

In the interior fluid, a deposit of the oxalate of lime had taken place. The entire deposit consisted of innumerable minute and delicately formed dumb-bell crystals, with here and there an octohedral crystal. In the interior fluid, unlike the exterior, there were over a hundred dumb-bell crystals to one octohedral crystal. Minute octohedra, and delicately formed dumb-bells were found within the meshes of the fibrous tissue. By comparing this experiment with the former ones, in which solutions of the same chemical substances were used, we are forcibly taught the following laws:

1. Mucous membranes from the same relative parts of the bodies of different animals, exert different physical influences upon the same chemical substances.

2. Mucous membranes from the same animal, but from different parts of the body exert different physical effects upon solutions of the same chemical substances.

3. The physical influence exerted by the membrane is not the same in endosmose and exosmose; it differs with the direction of the current.

A very important question now presents itself for our consideration. May not this change of form in the precipitates be due to the presence of some animal substance or fluid, as fibrin, blood, albumen or serum, and not to the physical action of the membranes? To determine this point, a series of careful experiments was instituted with the following substances: albumen, fibrin, yolk of hen's egg, warm blood, cold blood, putrescent blood, warm serum, cold serum, putrescent serum, and urine. In no case did the presence of these substances produce a crystalline deposit of the oxalate of lime. Each experiment was performed in several different ways, and under different circumstances; sometimes the density of the solutions of the chloride of calcium and oxalate of ammonia were varied, at others, the temperature and conditions of the foreign body. But one result attended all these experiments—no crystalline deposit. In many instances we have mingled the interior and exterior fluids, in both of which, crystals have been produced by the action of the membrane, and in every case the precipitate of the oxalate of lime thrown down consisted of irregular granules without any crystalline form whatever. Does not this prove conclusively that the simple presence of the different membranes did not cause the change of the physical form of the precipitate?

The next question which presented itself was, whether dry membranes exert a physical influence upon substances passing in solution through them, capable of changing their physical forms? To determine this point, we performed several experiments with dry membranes, with solutions of the chloride of calcium and oxalate of ammonia, varying the relative positions and densities of the fluids in each experiment. In no instance was a regular crystalline deposit obtained. In only one experiment, two or three octohedral crystals occurred in the midst of millions of irregular particles.

All our experiments thus far prove that dry membranes exert little or no physical influence upon chemical substances in solution passing through them.

Our next subject was to ascertain the influence of inorganic septa, during the endosmotic action. In our experiments we used thin vessels of baked clay. These were filled with a solution of chloride of calcium and immersed in a glass jar containing a solution of the oxalate of ammonia. The relative positions and densities of these fluids were also changed. In no instance did we obtain a regular crystalline deposit. So far, then, as our experiments go, we are able to assert that inorganic septa do not exert a physical influence upon chemical substances passing through them, capable of changing the arrangement of their molecules.

Experiment upon the Physical Influence exerted upon Chemical Substances in solution, as they pass through the cell walls of vegetables.—I immersed the cut end of a stalk of Indian corn in a solution of the chloride of calcium, and allowed it to remain for 18 hours, at the end of which time it was removed and placed in a solution of the oxalate of ammonia, in which it remained for a similar length of time. When thin slices of the corn-stalk were examined under a magnifying power of 210 diameters, a crystalline deposit of the oxalate of lime was found to have taken place within the hexagonal cells of the vegetable, differing widely from the deposit formed solutions of the oxalate of ammonia and chloride of calcium are brought into contact. The precipitate thus formed consisted of irregular granules.

The crystals deposited within the cells of the corn, differed widely also from those when the intestines of a raccoon or a sheep were filled with solutions of the ammonia, and immersed in solutions of the chloride of calcium.

I immersed sections of different lengths of the stem of a young and verdant bene a solution of the acetate of lead, and then transferred them to a strong solution of the sulphate of iron. When thin sections were examined under the microscope, beautiful and lozenge-shaped plates had crystallized in all the hexagonal cells.

When the broad thick leaf of an endogenous plant was placed alternately in the same chemical substances, a crystalline deposit took place within its cells, which in form from that within the cells of the bene plant. Different vegetables were different chemical solutions, which, when mingled, produced a deposit of irregular and in every instance a regularly crystalline deposit took place within their cells.

It is unnecessary to do more than recapitulate the following results:

1. Cell-walls, like animal membranes, exert a physical influence upon the chemical stances held in solution passing through them. This physical influence is capable of the arrangement of the molecules of the precipitate formed within the cells, so the precipitate which under ordinary circumstances consists of irregular granules, influence of the endosmotic action assumes a regular crystalline form.

2. The cells of different vegetables, like different animal membranes, change in manners the arrangement of the molecules of the same substance.

It may yet be demonstrated, by experiment, that cells in the same plant, having offices, elaborating different products, exert a different physical influence upon the mical substance. Or, in other words, the crystalline deposit of the same substance, in physical properties with different cells.

Experiments determining the action of the Sulphate of Magnesia, in solution, Living Animals.

Experiments with a solution made of the strength of the ordinary purging dose, one salt to eight fluidounces of water. Experiment 373..—8 o'clock P. M., Sept. 5th, 1855. incision along the linea alba of the abdomen of a cat; drew forward the stomach; ligature around the œsophagus, just above its junction with the stomach; duodenum; introduced the nozzle of a syringe, and threw into the stomach one the solution of the Sulphate of Magnesia. The duodenum was then tied between the and the stomach, thus inclosing completely the saline solution. The stomach and were carefully returned, and the edges of the incision so closely sewed together that no atmospheric air could enter. Previous to the experiment, the cat had been more than thirty hours; the stomach and intestinal canal were therefore completely Specific gravity of saline solution, 1055. The next morning the cat appeared strong. Upon pressing the abdomen, the bladder was felt, greatly distended with urine, had been excreted during the night, for the bladder was completely emptied during operation. By the exertion of pressure over the region of the bladder, its contents voided.

Sept. 7. The cat appeared strong and active, and passed about one fluidounce of yellow urine. It continued alive and strong, being able to walk about without any difficulty, until 1 o'clock P. M., of Sept. 8, when its throat was cut. The experiment sixty-five hours, during which time the cat, of course, took no food or drink. The was distended with urine, which was collected and retained for future examination. stomach contained one fluidounce and 2½ drachms, of a fluid almost transparent, slightly turbid aspect. It was to a small degree ropy, from the admixture of presence of which was further determined by the detection, under the microscope, rous mucous corpuscles. Reaction decidedly acid, turning thick litmus blue Specific gravity, 1014. Compare this with the original specific gravity of the saline 1055, and we see at once that the greatest portion of the solution had been absorbed. contents of the stomach were next evaporated to dryness, dissolved in water, treated with the acetate of lead until a precipitate ceased to fall. The precipitate treated with hydrochloric and acetic acids, alcohol and ether, to remove the lead and all organic matter. It was next evaporated to complete dryness upon the of calcium bath, and its weight accurately determined upon a delicate balance, turning to the thousandth part of a grain. A fluidounce of the original saline gr. 1055, was also treated with the acetate of lead until a precipitate of the ceased to fall. This was dried and weighed in like manner. Knowing the Sulphate of Magnesia contained in each fluidounce of the original solution, we the application of the rule of three, to ascertain the amount of the Sulphate of Magnesia corresponding to the sulphate of lead precipitated from the fluid of the stomach. The following are the terms used:

Weight of the precipitate of the sulphate of lead from one fluidounce of original saline solution. : Its corresponding weight of the sulphate of magnesia.
:: Weight of the precipitate of the sulphate of lead from the fluid of stomach. : Its corresponding weight of the sulphate of magnesia.

Amount of the sulphate of magnesia remaining in solution in the stomach of the cat, grains 9.43.

Amount of the sulphate of magnesia in solution, absorbed by the stomach in sixty-five hours, grains 46.09.

The intestines contained throughout their whole tract to the rectum, an orange-coloured, tough mucus, which, under the microscope, was found to consist of mucous corpuscles and epithelial cells from the mucous membrane; also, large, irregular cells, filled with yellow matter. The superior portion of the colon and rectum was filled with soft fecal matters, the existence of which we have never noticed in a starving cat or dog not under the action of medicines. According to our investigations in these cases, the excrementitious matters in the colon and rectum are hard and comparatively dry. Their presence in this instance indicated that a purgative effect was produced by the absorption of the sulphate of magnesia from the stomach.

The amount of the sulphate of magnesia contained in the urine was next ascertained. Amount of the sulphate of magnesia excreted by the kidneys in the last twenty-four hours of the experiment, grains 11.78. The former discharges from the bladder were not examined, because they were voided suddenly, rapidly, and upon the floor. The urine examined was remarkably rich in organic constituents.

The blood of the cat was next examined. The blood-corpuscles, like those of a dog which was operated on in a similar experiment, showed the marks of inflammation by conglomerating together in large numbers, resembling piles and rows of coins. The presence of inflammation was further indicated by the amount of fibrin existing in the blood. Amount of fibrin in 1,000 parts of blood 7.06. This is a much larger proportion of fibrin than usually exists in the blood of cats and other animals in a normal condition. The parts in the region of the wound bore the marks of inflammation. The lips of the wound had commenced to suppurate, and portions of the peritoneum had adhered to the abdominal cavity by the ejection of coagulable lymph. This was especially the case with the omenta.

Experiment 374.—10 o'clock A. M., Sept. 4, 1855. Made an incision along the linea alba of the abdomen of a dog; punctured the duodenum; introduced the nozzle of a syringe; threw into the stomach one fluidounce of the solution of the sulphate of magnesia; and passed a ligature around the duodenum, between the puncture and the stomach. A ligature was not passed around the œsophagus where it joins the stomach. Specific gravity of saline solution 1055. The dog had been deprived of food and water for twenty-four hours previous to the experiments, so that the stomach and small intestines were completely empty when the fluid was thrown in. The bladder of the dog was emptied during the operation.

In the course of two hours, about one-half fluidounce of bloody urine was discharged. At fifteen minutes before 3 o'clock P. M., four hours and forty-five minutes after the performance of the experiment, the dog vomited about one-half fluidounce of mucus and the solution of the sulphate of magnesia. The mucus was completely incorporated with the saline solution, so that the whole mass was viscid and ropy. At 5 o'clock P. M., passed one and a half fluidounces of clear urine. At 9 o'clock P. M., passed one-half fluidounce of clear urine.

On the morning of the next day, September 5, the dog appeared as strong as before the performance of the operation, and drank about one and a half fluidounces of water, which was vomited up in a few moments. The water thus vomited contained but small traces of the sulphate of magnesia. Although the dog vomited one-half fluidounce of mucus with the solution, still more than one-half the original amount was absorbed, and acted decidedly upon the kidneys. Three fluidounces of water were again drank by the dog, and again vomited. At 4 o'clock P. M., the dog vomited two fluidounces of mucoid fluid. After this it devoured with great greediness, the muscles of a young gray squirrel (*Sciurus Carolinensis*), cut into small pieces. At 9 o'clock P. M., five hours afterwards, the greatest portion of the meat was vomited, together with a fluid which contained mucus and gave a decidedly acid reaction. This meat had been acted upon by the gastric fluid. The exterior of the largest, and the entire substance of the smallest, particles presented a soft, white, gelatinous appearance, and, when pressed, were easily crushed beneath the fingers. The dog refused to take any further nourishment, and died in a few hours. Its bowels were moved shortly before death. Owing to the time of its death, after midnight, we were compelled to defer our examination until next morning.

The stomach was distended with gas, which probably was generated by the remaining particles of meat undergoing partial fermentation after death. The blood-vessels upon its exterior were filled with blood. Its internal mucous coat was of a light purplish pink color. The intestines were distended with gas, and contained a red, bloody viscid fluid, which, under the microscope contained blood-corpuscles altered in shape, epithelial cells, mucous corpuscles, large ellipsoidal cells containing granules, and irregular cells containing orange-yellow matter. Crystals, resembling the prismatic crystals of triple phosphate which occur in urine, were also present, in small numbers, in the contents of the intestines. The internal mucous coat was very red in color. When the blood was examined under the microscope, the blood-corpuscles were conglomerated together, indicating the presence of inflammation. The blood also contained numerous minute worms, the larvæ of larger ones, several inches in length, which were packed away in great numbers in the cavities of the heart, the larger blood-vessels, and in the structure of the lungs. It may be interesting to state that this dog was extremely poor, a mere skeleton, and I found it impossible to improve his condition, although he was liberally supplied with vegetable and animal food. And it is remarkable that the docility, courage, physical powers and tenacity of life in this dog did not appear to have been impaired by its condition, induced no doubt by the presence of these worms in the heart, lungs and blood-vessels.

Experiment 375.—In an experiment upon the absorption of fatty matters, I operated upon a remarkably large, powerful and intellectual pointer dog, which possessed the characteristics of the preceding dog, a voracious appetite, without any lasting benefit resulting from the consumption of enormous quantities of animal and vegetable food. His heart contained numerous worms, several inches in length, and exactly resembling those of this dog, (Ex. 374.)

With reference to the action of the gastric juice upon meat, we are aware that it conflicts with the theories of certain physiologists. We have, however, enjoyed many opportunities of demonstrating the fact that meat is digested in the stomach. and not in the small intestines. We have found in the stomach of an alligator, the bones and hair of an entire pig, without a particle of meat upon them. In the stomachs of others we have found fish, snakes, crabs, &c., in different stages of digestion; some, like the meat in the dog's stomach, slightly acted upon by the gastric juice; others partially dissolved; whilst of others little more than their bones remained. These facts have also been verified by an examination of the contents of the stomachs of snakes which feed upon mice and lizards.

We learn a practical lesson from this experiment; the œsophagus should always be tied. If this is not done, the animal is liable to vomit up the fluid injected into the stomach, and we will therefore be unable to ascertain the exact amount of the medicine absorbed.

By comparing these two experiments, we are taught the following:

1. Solutions of the sulphate of magnesia, of high specific gravity, are capable, if retained long enough, of being absorbed in the stomach.
2. After absorption, they excite both diuresis and purgation.
3. The main channel for the elimination of the sulphate of magnesia is by the kidneys.
4. Its elimination is accompanied by an increased amount of the solid constituents of the urine.

Several other conclusions are forced upon our minds, but we will reserve their expression until after the completion of this series of experiments upon saline solutions of high specific gravities.

Experiment 376: Ten minutes before 12 o'clock, May 25, 1855.—Opened the abdominal cavity of a cat by an incision along the linea alba, passed a ligature around the œsophagus above its junction with the stomach, introduced the nozzle of a syringe into a small incision into the duodenum, and injected one fluidounce of the solution of the sulphate of magnesia into the stomach. A ligature was then applied to the duodenum, between the puncture and the stomach.

A ligature was next passed around the colon, just above its junction with the rectum; the nozzle of the syringe was introduced into the puncture in the duodenum, and one fluidounce of the saline solution thrown into the intestines. Lastly, a ligature was applied around the intestine, a short distance below the incision, through which the solution of the sulphate of magnesia was injected into the stomach and intestines. The saline solutions were thus separately and completely inclosed in the stomach and intestines, without any possibility of their passage upwards or downwards. The stomach and intestines were returned to their natural positions in the abdominal cavity, and the incision carefully sewed up.

Specific gravity of solution of sulphate of magnesia 1053.

The specific gravity, as in all the subsequent experiments on living animals, was accurately determined upon a delicate balance capable of indicating the weight of $\frac{1}{1000}$ part of a grain. The length of the intestine inclosed between the two ligatures was three feet.

As usual, the cat, before the operation, was kept without food or drink for twenty-four hours. During the operation, which occupied ten minutes, one of the small arteries which supply the intestines were cut, and speedily tied, with little loss of blood.

The bladder was completly emptied, and fecal contents discharged from the rectum during the operation. Afterwards, several times, small amounts of urine were discharged, but no fecal natters. At ten minutes after 8 o'clock P. M., eight hours after the operation, the cat was examined. It was in an exceedingly feeble condition. The blood-vessels upon the exterior of the stomach were injected and distended with blood.

Amount of fluid in the stomach one fluidounce and seven drachms. In eight hours it had increased seven fluiddrachms. The fluid was without odor, and contained large quantities of transparent mucus, which was so thoroughly incorporated with the saline solution, that it poured like flaxseed tea. There were also masses of dense mucus floating about.

Under the microscope, with a magnifying power of 210 diameters, it contained mucous corpuscles and epithelial cells. The next morning numerous single cells, animalcules, were seen sporting about.

In the denser masses of mucus there were several dark looking flocculi, which, under the microscope, consisted of blood-corpuscles and coagulated fibrin. The amount of blood in this state did not exceed one or two drops, and was, most probably, derived from the nozzle of the syringe which came in contact with the bleeding edges of the wound in the duodenum. When treated with heat and nitric acid, only a slight cloudiness was produced, showing the presence of albumen in very small amount. It was without doubt, introduced into the stomach in a manner similar to that of the blood-corpuscles.

Specific gravity of the fluid in the stomach 1026. The amount of sulphate of magnesia contained in it, as ascertained by the method described in the first experiment, was grains 49.5. Amount of sulphate of magnesia which had passed out of the stomach, grains 6.02. Each fluidddrachm of the original solution held grains 6.94 of the sulphate of magnesia in solution, consequently about one fluiddrachm of the original solution had passed out of the stomach, while six fluiddrachms of the fluid from the blood had passed in. The internal mucous coat of the intestines was of a pinkish red color, the vessels which supplied it with materials for secretion and nutrition being congested with blood.

Examination of the Intestines.—The blood-vessels on the exterior of the intestines were filled with blood, and the whole surface was reddened. This was not the case with the surface and blood-vessels of the adjoining intestine which was not filled with saline solution; they presented a natural appearance. The internal mucus surface was reddened, and presented numerous spots of a dark purplish-red color.

Amount of saline solution one fluidounce, seven drachms. The increase of the saline fluid in the intestines was exactly equal to that in the stomach, notwithstanding that the surface exposed in the former was many times greater in extent than that of the latter.

The fluid was of a light red color, and its odor similar to that of the fecal matters of cats, only considerably aggravated. The intestine included between the two ligatures, embraced the jejunum, ilium, and the greater portion of the colon. Specific gravity of the fluid from the stomach 1022.

Heat and nitric acid revealed the presence of albumen in minute quantity.

After standing for several hours, a light colored sediment settled at the bottom of the vessel, which, under a magnifying power of 210 diameters, consisted of epithelial cells from the mucous membrane, other large irregular cells, and a few crystals of the triple phosphate. The supernatant fluid contained these in less quantities.

Amount of the sulphate of magnesia in the fluid of the intestines, grains 41.25.

Amount of the sulphate of magnesia which had passed out of the stomach, grains 14.27.

Each fluiddrachm of the original solution held grains 6.94 of the salt in solution, consequently about two fluiddrachms of the original solution had been absorbed, whilst nine fluiddrachms of the fluid from the blood passed in. In both the stomach and intestines the amount of the saline solution was equal at the commencement and end of the experiment, whilst the absorption had been twice as great in the intestines.

Experiment 377; *Repetition of Experiment* 376: Secured in the stomach of a cat in the usual manner, with ligatures around the œsophagus and the duodenum, one fluidounce of the solution of the sulphate of magnesia. One fluidounce of the same solution was also introduced into the intestines in the usual manner and secured with ligatures.

Specific gravity of saline solution 1055.

Operation performed at 12 o'clock at night. The cat appeared to suffer considerably during the operation, but as soon as the wound was sewed up, it gave no indications of pain, but commenced, when stroked upon the head, a vigorous purring. The operation was conducted without accident, and only a few drops of blood from the cutaneous veins and arteries were lost.

Previous to the experiment, the cat was kept without food and drink for thirty-six hours, the stomach and intestines, therefore, were completely empty when the fluids were introduced.

The cat was found dead at 9 o'clock A. M. next morning.

The blood-vessels upon the exterior of the stomach were congested with blood. internal mucous coat showed a high state of irritation, being of a purplish color. small spots were visible of a deep purple.

The stomach contained one fluidounce, three drachms, of a light pinkish colored taining much mucus. Specific gravity 1035.8. Heat and nitric acid produced only a precipitate. Albumen was present in an amount just sufficient to manifest itself in a manner, and was, no doubt derived from a drop or two of blood accidentally introduced the experiment. Under the microscope, the fluid contained nucleated epithelial cells the mucous membrane, also the mucous corpuscles.

Amount of the sulphate of magnesia remaining in the fluid of the stomach, grains

Amount of the sulphate of magnesia which had passed out of the stomach, grains

Each fluiddrachm of the original solution contained grains 6.94 of the sulphate of consequently one fluiddrachm and forty minims of the original solution, or three and a fluiddrachms of the fluid in its present state of dilution, passed out.

Examination of the Intestines.—The blood-vessels on the external surface of the and in the peretoneum were congested with blood, and the whole surface was reddened.

The internal surface was coated over with light-yellow mucus and epithelial cells. this was gently scraped off, the mucous coat was found congested with blood, being of a plish-pink color, very deep in some parts, and in others lighter.

Amount of fluid in the intestines two fluidounces, four drachms. The fluid was of a ish red color, and contained a large amount of thick mucus, epithelial cells, also yellow cells. Its odor was fetid, extremely disagreeable and capable of nauseating machs. Specific gsavity 1018.6.

When treated with heat and nitric acid the presence of albumen was promptly It was present in considerable quantities. In addition to the cells above mentioned, microscope revealed the presence of innumerable crystals which pervaded the whole and were visible to the naked eye as minute silvery particles. In form, the majority of were prisms, exactly resembling the prismatic crystals of the triple phosphate of ammonia, and magnesia, found in the urine of man and all animals. They were in water.

A portion of the fluid was diluted with more than six times its volume of water, and to stand for more than two weeks, and at the end of this time, they were unchanged in or numbers.

They were insoluble in aqua ammoniæ and liquor potassæ, and completely soluble in hydrochloric, and acetic acids. These, and other chemical tests, prove these crystals triple phosphate.

Amount of the sulphate of magnesia remaining in the fluid of the intestines, grains

Amount of sulphate of magnesia which was absorbed, grains 30.04.

If the original solution was absorbed without dilution, more than four fluiddrachms out of the intestines; if, however, it was not absorbed until its present state of dilution, grains of the sulphate of magnesia would have required an amount of fluid greater than existing in the intestine. By comparing the effects produced by saline purgatives on stomach and intestines, we see that, in equal lengths of time, the intestines absorb much rapidly than the stomach.

In the stomach, 11.31, grains whilst in the intestines, in the same length of time, 30.04 of the sulphate of magnesia were absorbed.

The increment of the fluid in the stomach was three fluiddrachms, whilst that of the tine was twelve fluiddrachms. The effort to relieve the blood-vessels of their congestion dilute the saline fluid, and render its properties less irritating by the admixture of was four times greater in the intestines than in the stomach.

By carefully considering and comparing these experiments, we arrive at the conclusions:

1. The primary action of a solution of the sulphate of magnesia, of high gravity, is that of an irritant. The impression is transmitted to the nerves. their influence, blood is determined to the stomach and intestines. The blood are congested, absorption is consequently almost entirely arrested. The mucous brane is excited to increased and rapid secretion of a watery mucous fluid. The of this secretion are to unload the blood-vessels and dilute the internal saline and thus mitigate its irritant properties.

The saline solution is not immediately absorbed; it must be first prepared, this, time is required. This first stage of the action of a saline purgative is to that of a blister, with this difference, that mucus and excrementitious matters, instead of serum, are poured out.

2. Absorption of the saline solution, in an appreciable degree, does not take place until the blood-vessels are partially relieved, and the fluid sufficiently diluted.

The fact that absorption is arrested by a congested state of the blood-vessels, depends almost entirely upon mechanical principles. If pressure be exerted upon a fluid contained in a porous body, it tends to escape through the pores of that body. Water has been forced through the pores of a thick vessel of gold. That pressure is exerted upon the particles of the blood by some force, is seen in the fact, that the elasticity of the veins, arteries and capillaries, has been overcome.

When the vessels are distended with blood, its flow is necessarily retarded, and, perhaps, almost entirely stopped. This stagnation of the blood, also by a physical law, prevents the absorption of the saline solution.

Motion of the fluid on one side, always promotes the passage through of that on the other, because it is carried away into the general circulation as soon as absorbed, the rapidity of absorption bearing a direct ratio to the miscibility of the fluids.

When the blood is at rest, the saline solution, which passes through the delicate membrane into the capillary vessels, is slowly diffused, so that we have a saline solution of almost the same strength, both in the stomach, in the intestines, and in the capillary vessels. When two saline solutions, separated by a membrane, are of the same strength, the endosmotic flow is not excited, because the end of all endosmotic action, the establishment of equilibrium, exists.

3. Living animal membranes, unlike dead animal membranes, do not allow the constituents of the blood to pass indiscriminately through them, but select, alter, elaborate and separate, certain definite materials.

The active agents in this process are the living cells, which exert a controlling influence upon endosmose and exosmose. They elaborate and allow to pass through their walls, only certain definite substances, the chemical characters of which depend not so much upon the foreign fluid or substance, which excites the cells, as upon the structure, functions and vital endowments of the cells. Hence the absorption and action of saline purgatives in the animal economy cannot be exemplified, and its law determined by experiments performed with dead animal membranes. The question immediately arises, how do cells which are mere sacs filled with fluid, accomplish these powerful vital actions, elaborating materials often so complex in their characters, that the most learned chemists are puzzled in their analysis? This is one of the most important inquiries in science.

4. The congestion of the blood-vessels, and the increased flow of thin, watery, mucous fluid cannot be caused indiscriminately by all fluids.

I inclosed common lard oil, in the usual manner, in the stomach and intestines of a pointer dog, and also milk in the stomach of a cat, and allowed them to remain a length of time corresponding to that consumed in these experiments. In neither case were the blood-vessels upon the exterior or interior of the stomach and intestines in the slightest degree congested, and there had been no flow of watery, mucous fluid.

5. The solution of sulphate of magnesia, after its absorption, excites an increased flow of the urine, accompanied with an increase of its solid constituents, and also produces purgation, attended with the excretion, by the intestines, of certain effete fœtid matters. The action is not confined to the kidneys and intestines, for the matters which they eliminate from the blood, pre-exist in that fluid, and are simply separated by these organs.

The saline solution probably acts chemically upon the effete products of the metamorphoses of the tissues, accelerating their breaking down and removal into the general circulation, and final elimination from the blood. They may also excite the nerves and vital forces which preside especially over the metamorphoses of the organic elements of the body.

6. The absorption of saline substances, is much more rapid in the stomach, whilst

the effort at their dilution is very nearly equal in both, notwithstanding the disparity between the surfaces exposed to their influence. The first fact is readily accounted for, when we reflect that the office of the stomach is that of secretion, rather than of absorption, whilst that of the intestines is the reverse. The fact that the stomach, with a small surface, dilutes the saline solution as much as the intestines, exposing a much greater secreting surface, proves that there is a regular standard, to which a dense saline solution must be diluted before it can be absorbed.

Experiments with Weak Saline Solutions.

Experiment 378.—Opened the abdomen of a cat which had been starved for 24 hours, and secured in its stomach, in the usual manner, one fluidounce of a solution of the sulphate of magnesia; one fluidounce of the same solution was also introduced into the intestines and secured in the usual manner, with ligatures. Specific gravity of saline solution, 1004.5.

The next morning, 12 hours afterwards, the cat was alive, and showed considerable life and strength. It was killed and its viscera examined. The blood-vessels upon the exterior of the stomach were congested with blood, those of the pyloric extremity being more congested than those of the cardiac portion. The stomach was next punctured, and its contents carefully removed into a graduated measure. It contained a large mass of dark beeswax, which was felt during the operation. Amount of fluid in the stomach, six fluiddrachms and twenty minims. It had lost one fluiddrachm and forty minims.

The mucous membrane appeared congested with blood, being of a pinkish red color, and in several spots where the blood was much congested, was of a purplish scarlet color. The fluid from the stomach was of a reddish yellow color. Specific gravity, 1007.7.

The specific gravity had increased instead of diminishing. This increment is, without doubt, due to the admixture of mucus. Under the microscope, the fluid contained nucleated epithelial cells and mucous corpuscles. Heat and nitric acid gave a slight cloudiness, just sufficient to show the presence of the small amount of albumen which was introduced into the stomach, in the blood upon the nozzle of the syringe.

Amount of the sulphate of magnesia remaining in the stomach, grains, 5.37.

Amount of the sulphate of magnesia which had been absorbed, grains, 1.29.

Each fluiddrachm of the original solution contained grains, 0.832, of the sulphate of magnesia; consequently one fluiddrachm and twenty-eight minims of the original solution must have been absorbed.

Examination of the Intestines.—The intestines presented a natural appearance, and the blood-vessels upon their exterior were not congested with blood. The internal mucous coat presented also the same natural condition. All the saline solution had been absorbed. The intestines contained thirty minims of a yellowish red, fœtid matter, which, under the microscope, contained mucous corpuscles, epithelial cells, and other irregular masses.

The bladder, which had been completely evacuated during the operation, was about one-fourth full of urine, and had been emptied during the night, showing that the kidneys were acted upon. This experiment, like the preceding, demonstrates that solutions of the sulphate of magnesia are more readily absorbed in the intestines than in the stomach.

In the stomach, one fluiddrachm and forty minims were absorbed, whilst in the intestines, in the same length of time, the whole amount of the saline solution had been absorbed.

Experiment 379.—*A repetition of the last Experiment.*—Secured in the stomach of a cat, in the usual manner, one fluidounce of a weak solution of the sulphate of magnesia; also the same amount of this saline fluid in the intestines. Specific gravity, 1004.5.

The cat remained alive, and showed considerable activity and vitality during the night. Towards morning, however, it grew feebler, and expired 13 hours after the completion of the operation. The surface of the stomach showed very little more congestion than what was natural. The mucous coat showed a slight congestion, being redder than usual, but far less than the mucous membrane of stomachs which had been in contact with dense saline solutions. Its fluid contents were transparent, and contained mucus. Amount, seven fluiddrachms. It had lost by absorption, one fluiddrachm. Specific gravity, 1008.

The increase in the specific gravity was, without doubt, due to the presence of mucus. When treated with heat and nitric acid, a slight, cloudy precipitate took place, showing the presence of albumen in very small amount, the existence of which could be accounted for by the same accidents which occurred in other experiments.

Amount of the sulphate of magnesia remaining in the stomach, grains, 6.42.

Amount of the sulphate of magnesia which had been absorbed, $\frac{24}{100}$ of a grain.

Each fluiddrachm of the original solution contained 0.832 of a grain of the salt; consequently, 0.590 of a grain of the sulphate of magnesia had been retained in the stomach, while only pure water was absorbed.

ation of the Intestines.—The intestines contained none of the saline solution, the blood-
pon their exterior showed little or no congestion, and the mucous coat presented a
ppearance. They contained, as in the former experiment, forty minims of a dirty,
a-red, semi-fluid mass, having an extremely fœtid odor, and composed of the same
, and resembled in all respects the contents of the intestines of the preceding cat.
der contained one fluiddrachm of urine, which had been excreted during the night, for
en completely evacuated during the operation.

mparing these experiments with those in which dense saline solutions were used,
e at the following conclusions:

The primary irritant effect of a weak saline solution, is much less upon the
and intestines than that of a dense solution.

The congestion of the blood-vessels being less, and the difference between the
densities of the exterior and interior fluids being greater, absorption is much
pid.

The stomach is much more readily irritated by a weak saline solution, and its
ent secretion of mucus much greater than that of the intestines.

The relative absorbing power of the stomach is much less than that of the intes-
This law holds good, both for dense and weak solutions of the sulphate of mag-

After its absorption, a weak solution of the sulphate of magnesia acts principally
e kidneys, and promotes the breaking up and final elimination of effete matter.
also, but in a much feebler degree, excite the depurative action of the intestines.

MENTS UPON THE RECIPROCAL ACTION OF SERUM AND SOLUTIONS OF THE SULPHATE OF MAGNESIA, THROUGH DEAD ANIMAL MEMBRANES.

ments on the reciprocal action of Serum and dense Saline Solutions through Dead Animal Membranes.

ment 380.—In this experiment, the serous fluid from a hydrocele of the tunica vagin-
s was used. When heated, or treated with acetic and nitric acid, the albumen was
ed in large quantities. Phosphate of soda, liquor potassa, and phosphate of ammonia,
no precipitate or perceptible change. These reactions should be borne in mind
he subsequent examinations.

uced into nine inches of pig's intestine, one and a half fluidounces of the serous fluid,
aring both ends, immersed it in a solution of the sulphate of magnesia, made in the
of one fluidounce of salt to eight fluid ounces of water. Specific gravity, 1056.
gravity of serous fluid, 1021. Examined three hours afterwards. Specific gravity of
rior saline solution, 1049.

nd nitric acid threw down copious precipitates of albumen, showing that the serum
ed from the interior and mingled with the exterior fluid. Specific gravity of interior
35. Amount, one and a half fluidounces and thirty minims.

rous fluid had gained by endosmose, thirty minims. The albumen in the serous
completely coagulated by heat, until nitric acid failed to give the slightest precipi-
was then removed by filtration.

esence of the sulphate of magnesia in the fluid portion of the serum, thus freed from
was indicated by the precipitate of the sulphate of lead and magnesia, thrown down
etate of lead, liquor potassæ, and phosphates of ammonia and soda.

experiment, the exterior fluid had lost in specific gravity 7 degrees in the thousand,
e exterior fluid had increased in amount thirty minims, and in specific gravity 14
the thousand.

n in the specific gravity of the serous fluid had been much more rapid than its gain
t. These facts render it probable that, after the endosmose of the saline solution,
y portion of the serous and saline fluids must have flowed back, leaving a certain
f the sulphate of magnesia in a more concentrated form.

ent 381.—Secured in 12 inches of the colon of a sheep having the peritoneum on,
ounce of serum from the blood of the same animal, and immersed it in a solution of
hate of magnesia, made in the strength of one fluidounce of salt to eight fluidounces
; examined after 17 hours. The interior saline solution was colored red. Amount
, one fluidounce and ten minims. The exterior saline solution gave indications of
nce of albumen, and the change in the specific gravities showed that an interchange
id had gone on.

Experiment 382.—The same length of sheep's colon, and a saline solution of the same strength were used, as in the preceding experiment; the relative position of fluids, however, was reversed, the saline solution being in contact with the internal mucous coat. Amount of solution of the sulphate of magnesia, one fluidounce. Examined 18 hours afterwards. Interior saline solution had assumed a pinkish color, and measured six fluiddrachms, having lost two fluiddrachms. The action of nitric acid and heat showed the presence of albumen. The exterior serous fluid gave indications, with the appropriate chemical tests, of the presence of the sulphate of magnesia.

Experiment 383.—Repetition of experiment 381, using the same length of intestine and the same relative position of the fluids; specific gravity of the saline solution, 1053. Specific gravity of serum, 1020. Examined after 17 hours. The interior serum measured seven fluiddrachms, and had lost one fluiddrachm. Chemical tests demonstrated the presence of the sulphate of magnesia in the serum, and that of albumen in the exterior saline solution.

Experiment 384.—Secured in 36 inches of the small intestine of a sheep, not deprived of peritoneum, one fluidounce of the serum of the same animal, and immersed it in a solution of the sulphate of magnesia. Specific gravity, 1053. Examined 17 hours afterwards. Amount of interior serum, one fluidounce; it had not increased or decreased, and yet the characteristic chemical tests gave unquestionable evidence of the presence of the sulphate of magnesia in the interior serum, and of albumen in the exterior saline solution. Here endosmose and exosmose had been equal.

Experiment 385: The same length of intestine, and the same fluids were used, but their relative positions were reversed; the solution of the sulphate of magnesia, instead of the serum, being inclosed in the intestine. This then may be called the reverse of the last experiment (384). Examined 17 hours afterwards. Amount of interior saline solution, seven fluiddrachms. The greatest flow was from the saline solution to the serum, one fluiddrachm of the interior having passed out.

By carefully comparing these experiments, we see that in four out of six, the greatest flow was from the saline solution to the serum, although the specific gravity of the former was much greater than that of the latter. In one of the other experiments, the endosmotic and exosmotic actions were exactly equal, whilst in the remaining one, the greatest flow was from the serum to the saline solution, in obedience to the law stated by numerous observers, that the flow is always from the less dense to the denser liquid. This law does not hold good when a solution of the sulphate of magnesia and serum are the fluids employed.

The relative position of the membranes exerts a controlling influence upon the passage through of fluids. This fact has been almost entirely overlooked by observers. In experiments 380, 381, 383 and 384, the serum was placed in contact with the internal mucous membrane, whilst the saline solution was in contact with the exterior serous coat of the intestine.

In experiment 380, the serous fluid gained thirty minims.

In experiment 381, the serous fluid gained twenty minims.

In experiment 384, the serous fluid had neither lost nor gained.

In experiment 383, the serous fluid lost sixty minims.

In experiments 382 and 385, the saline solution was placed in contact with the internal mucous membrane, and the serum in contact with the external serous coat of the intestines.

In experiment 382, the saline solution had lost two fluiddrachms.

In experiment 385, the saline solution had lost one fluiddrachm.

When the mucous surface was in contact with the serum, the flow of the saline solution towards the serum was retarded, and that of the serum increased.

When the mucous coat was in contact with the saline solution, its passage through the membrane was greatly accelerated, whilst that of the serum was diminished.

The fact that solutions pass much more readily out of dead animal membranes, from the interior to the exterior, might be illustrated by numerous examples. The result of these experiments demonstrated conclusively that the laws regulating the action of saline purgatives upon living animals, cannot be determined by experiments performed with dead animal membranes. In living animals their primary impression is always attended with a rapid flow from the blood to the saline solution, whilst the reverse takes place in dead animal membranes.

Experiments on the reciprocal Action of Serum and weak Saline Solutions through Dead Animal Membranes.

Experiment 386: Introduced one and a half fluidounces of the serous fluid from the hydrocele of the tunica vaginalis testis, into 9 inches of pig's intestines and immersed it in a solution of the sulphate of magnesia, having a specific gravity of 1010. Amount of saline solution, four fluidounces. Specific gravity of serous fluid, 1021.

Examined three hours afterwards:

Specific gravity of exterior saline solution 1010.

Specific gravity of interior serous fluid, 1019.

Amount of interior serous fluid, one and a half fluidounces and forty minims.

The serous fluid had gained forty minims, and after the careful removal of all the albumen, the appropriate chemical tests indicated the presence in it of the sulphate of magnesia. The presence of the serous fluid was also determined in the saline solution.

Experiment 387: The same length of intestine and the same fluids were used in this experiment, only their relative positions were reversed, one and a half fluidounces of the saline solution being confined in the intestines, and immersed in four fluidounces of the serous fluid.

Specific gravity of interior saline solution, 1010.

Specific gravity of exterior serous fluid, 1021.

Examined three hours afterwards.

Specific gravity of serous fluid, 1020.

Specific gravity of saline solution, 1010.

Amount of interior saline solution, one fluidounce, and three fluiddrachms. It had lost one fluiddrachm.

The appropriate chemical tests showed that there had been an interchange of the fluids.

Experiment 388: Introduced one fluidounce of serum of pig's blood, into the intestine of this animal, and immersed it in a solution of the sulphate of magnesia.

Specific gravity of serum, 1018.

Specific gravity of saline solution, 1009.

Examined five hours afterwards.

Specific gravity of serum, 1018.

Specific gravity of saline solution, 1010.

Quantity of serum, one fluidounce, fourteen minims.

Chemical reagents showed the presence of serum in the saline solution, and also of the sulphate of magnesia in the serum.

By comparing these last experiments, the facts are demonstrated that the greatest flow was from the saline solution to the serum.

The rapidity of this flow was moderated by the position of the membrane.

In Experiments 386 and 388 in which the serous fluid was placed in contact with the internal mucous membrane, the external saline solution in contact with the serous coat of the intestines, lost in the first, forty minims, and in the last, fourteen minims. When, however, the relative positions of the fluids were reversed, as in Experiment 387, and the saline solution was placed in contact with the mucous membrane, the internal solution of the sulphate of magnesia lost sixty minims. In each experiment the greatest flow was from the saline solution to the serum, but when the saline solution was placed in contact with the mucous membrane, the flow was in one instance one-third, and in the other nearly four times more rapid.

Out of 10 experiments with the serum of different animals, in which the relative densities and positions of the fluids were varied, in only a single instance was the greatest flow from the serum to the saline solution, and in this case the serum was in contact with the mucous membrane of the intestine.

From these facts, then, we are justified in laying it down as a general law, that with dead animal membranes, the greatest flow is from the saline solution to the serum, regardless of the strength of the saline solution, and this flow is greatest in the direction from the interior surface to the exterior of the membrane.

Does this physical law explain the action of saline solutions upon the animal economy? By no means. We have shown that when a strong saline solution is used, both in the intestines and in the stomach, the flow is from the blood to the saline solution, and it is not until that solution becomes diluted to a certain extent, that its absorption commences in an appreciable degree. When, on the other hand, a weak saline solution is used in the stomach, it obeys the physical law laid down. In the intestines it is totally and rapidly absorbed.

EXPERIMENTS ON THE RECIPROCAL ACTION THROUGH DEAD ANIMAL MEMBRANES, OF WATER AND SALINE SOLUTIONS OF DIFFERENT DENSITIES.

Experiments on the reciprocal action through dead Animal Membranes, of Water and dense Saline Solutions.

Experiment 389: Introduced into eighteen inches of pig's intestine, having the peritoneum on, two and a half fluidounces of a solution of the sulphate of magnesia, and immersed it in pure water.

Strength of saline solution one fluidounce of salt to eight fluidounces of water, specific gravity, 1056.

Four hours afterwards the amount of the saline solution was found, by measurement, to be three fluidounces and forty-eight minims. It had gained four fluiddrachms and forty-eight minims, specific gravity, 1040.

Specific gravity of the exterior fluid, which was originally pure water, 1009.

The presence of the sulphate of magnesia was also indicated by all the appropriate chemical tests.

Experiment 390: The same length of intestine, the same strength and relative position of the fluids were used in this as in the last experiment. The only difference was that the peritoneum was stripped off. At the expiration of four hours, the internal saline solution measured three and a half fluidounces, having gained one fluidounce. Specific gravity, 1037. Specific gravity of the exterior fluid, 1014.

This had a distinct saline taste, and, when treated with the appropriate chemical tests, the presence of the sulphate of magnesia was promptly indicated.

Experiment 391: Into eighteen inches of hog's intestine, with the peritoneum on, introduced six fluidounces of pure water, and immersed it in a solution of the sulphate of magnesia. Specific gravity, 1056. Four hours afterwards the interior solution measured five fluidounces and fifty-three minims, having lost seven fluiddrachms and seven minims. Specific gravity, 1016. The appropriate tests showed the presence of the sulphate of magnesia. Specific gravity of exterior saline solution, 1045.

Experiment 392: Similar in all respects to the preceding experiment, except that the intestine was deprived of its peritoneal coat. In four hours the internal fluid measured four and a half fluid ounces, having lost one and a half fluidounces. Specific gravity, 1019. Specific gravity of exterior saline solution, 1037.

Experiment 393: Into eight inches of pig's intestine, having the peritoneum on, introduced one fluidounce of a solution of the sulphate of magnesia, having the usual specific gravity, 1056, and immersed it in pure water for seven hours. At the end of this time the interior fluid measured one fluidounce, one and a half fluiddrachms. Specific gravity of exterior fluid, 1008.

Experiment 394: The same as the preceding experiment, except that the peritoneum was stripped off. Examined seven hours afterwards. Amount of interior fluid one fluidounce, one fluiddrachm. Specific gravity of the exterior fluid, 1005.

Experiment 395: Into eight inches of pig's intestine, having the peritoneum on, introduced two fluidounces of pure water, and immersed it in a solution of Epsom salts. Specific gravity, 1056. After seven hours the interior fluid measured one and a half fluidounces, one fluiddrachm and twenty minims. It had lost two fluiddrachms and forty minims. Specific gravity, 1033. Specific gravity of exterior solution. 1030.

Experiment 396: *Repetition of last experiment without the peritoneal coat.*—After the same length of time the internal fluid measured one and a half fluidounces, having lost four fluiddrachms. Specific gravity, 1033. Specific gravity of exterior saline solution, 1049.

These experiments were repeated, and in every case the results were similar to those above, and supported the following conclusions:

A mutual interchange of the fluids always took place, and the greatest flow was from the water to the saline solution. The rapidity of the flow depended upon the position of the membrane. The flow was greatest from the internal mucous coat to the exterior. The presence or absence of the peritoneal coat also modified the rapidity of the flow. The endosmotic and exosmotic actions were most vigorous when the peritoneal coat was absent. The rapidity of the interchange of the fluids varied with the employment of the intestines of different animals. As a general rule, it was more rapid in the intestines of the pig than in those of the sheep or cow.

The following tables will illustrate these points:

Saline solution inclosed in intestines having the peritoneal coat on.

Amount of fluid introduced.	Length of intestine.	Time.	Amount gained.	Sp. gr. of exterior fluid.
3 fluidounces.	Sheep's 36 inches.	3½ hours.	2 fluiddrachms.	——
4 "	Cow's 12 "	4 "	2 "	——
2½ "	Pig's 18 "	4 "	4 " and 48 minims.	1009
1 "	Pig's 8 "	7 "	1½ "	1008

Water inclosed in the intestine having the peritoneum on.

Amount of fluid introduced.	Length of intestine.	Time.	Amount lost.	Sp. gr. of interior fluid.
2 fluidounces	Sheep's 24 inches.	3½ hours.	3 fluiddrachms and 12 minims.	1010
2 "	Pig's 8 "	7 "	2 " 12 "	1033
6 "	Pig's 18 "	4 "	7 " 7 "	1016

Saline substances inclosed in intestines deprived of the peritoneum.

Amount of fluid introduced.	Length of intestine.	Time.	Amount gained.	Sp. Gr. of exterior fluid.
2½ fluidounces.	18 inches.	4 hours.	1 fluidounce.	1014
1 "	8 "	7 "	1 fluiddrachm.	1035

Water introduced into intestines deprived of peritoneal coat.

Amount of fluid introduced.	Length of intestine.	Time.	Amount lost.	Sp. gr. of interior fluid.
6 fluidounces.	Pig's 18 inches.	4 hours.	1½ fluidounces.	1019
2 "	Pig's 8 "	7 "	4 "	1033

Experiments on the reciprocal Action through Dead Animal Membranes, of Water and weak Saline Solutions.

Experiment 397: Into eight inches of pig's intestine, having the peritoneum on, introduced one fluidounce of common salt (chloride of sodium, made in the strength of one fluiddrachm of salt, to four fluidounces of water, and immersed it in pure water. Examined eight hours afterwards. Amount of the interior fluid, one fluidounce, forty minims. It had gained forty minims. The exterior fluid showed the presence of the chloride of sodium by giving a precipitate (chloride of silver,) when treated with the nitrate of silver.

Experiment 398: Repetition of the last experiment in all respects, except that the peritoneum was stripped off. Examined eight hours afterwards. Amount of interior fluid one fluidounce. Specific gravity of exterior fluid, 1005. Here endosmose of the water had just equalled the exosmose of the salt. A copious precipitate of the chloride of silver upon the addition of a solution of the nitrate of silver, demonstrated the presence of the chloride of sodium in the exterior fluid.

Experiment 399: Introduced into six inches of pig's intestine, deprived of the peritoneum, one and a half fluidounces of a solution of the sulphate of magnesia, and immersed it in pure water. Specific gravity of saline solution, 1009. Examined four and a half hours afterwards. Specific gravity of interior fluid 1007. Specific gravity of exterior fluid, 1001.5. Amount of internal fluid one fluidounce, seven fluiddrachms. It had gained three fluiddrachms.

Experiment 400: The same length of intestine and strength of saline solution were used, but the relative position of the fluids was reversed, the water being inclosed in the intestine. Examined four and a half hours afterwards. Specific gravity of exterior fluid, 1007.5. Quantity of interior water one and a half fluidounces, five fluid drachms. Specific gravity 1005. The internal water had gained five fluiddrachms.

Experiment 401; Introduced into twelve inches of pig's intestine, three fluidounces of a solution of the acetate of lead, and immersed it in pure water. The intestine was deprived of its peritoneal covering. Strength of the solution, three grains of acetate of lead to one fluidounce of water. Specific gravity 1005. Allowed to remain three and a half hours.

Amount of fluid in the intestine seven fluiddrachms, twelve minims. It had diminished forty-eight minims. Specific gravity 1004. Specific gravity of exterior fluid 1002. The addition of a solution of the iodide of potassium to the external solution (originally pure water,) was attended with a distinct orange yellow precipitate of the iodide of lead, indicating the presence of the acetate of lead.

By comparing these experiments, the fact is confirmed that in every case there was a reciprocal action and free interchange of the fluids upon opposite sides of the dead animal membranes.

Upon a comparison of these experiments with those in which strong saline solutions were used; it will be discovered that the influence of the presence or absence of the peritoneal coat, and of the relative position of the membranes, is not exerted in a definite manner when weak saline solutions are used. Also, that the reciprocal action of water and weak saline solutions through dead animal membranes, is not governed by the same fixed laws as the interchange of water and dense saline solutions.

When compared with the experiments upon living animals, the fact is conclusively demonstrated that the laws which regulate the action of saline solutions upon living animals, cannot be demonstrated or illustrated by experiments performed with dead animal membranes.

The truth of this proposition is still farther evident, when we consider the large amount of fluids thrown into the alimentary canal during specific periods of time. Thus the quantity of Gastric juice secreted, appears to be enormous. In dogs, the daily quantity has been calculated by Corvisart, as one-twentieth, and by Lehmann, as one-tenth part of the weight of the body. The latter ratio would give 14 lbs. in a man of 140 lbs. weight, a quantity equal to rather more than 11 pints daily. That this estimate, however large, is not extreme, is shown by the fact, that in a case of gastric fistula, in a woman, the estimated daily quantity was 30½ lbs. av.; the weight of the body being 116 lbs. The quantity of saliva secreted in twenty-four hours, by all the glands, has been estimated at from 1 to 3 lbs. According to Kölliker, H. Müller, and other physiologists, the quantity of bile secreted daily in dogs with artificial biliary fistulæ, is about ½ oz. to every pound weight of the animal, or $\frac{1}{32}$ part of its weight. This estimate if applied to a man weighing 140 lbs. would give 70 ozs. or 4 lbs. 6 oz. avoirdupois in a day, of which about $\frac{1}{25}$th, or nearly 3 oz. would be solid matter. This estimate is considered by some physiologists to be too high. Bidder and Schmidt, calculate the daily quantity secreted by a man to be 56 ozs.; Nasse and Platner's observations on the dog, would give a total daily quantity for man of 33½ ozs.; whilst others again have estimated it at only from 17 to 24 ozs. The quantity of pancreatic juice secreted daily in animals, varies according to different observers, from 15 to 35 grains per hour for each pound weight of the body; so that in a man weighing 140 lbs., the quantity secreted would be from 4¾ ozs. to 11 oz. per hour. The Pancreatic Secretion, as well as the Gastric Secretion is probably not continuous, but related to the process of digestion. From these fluctuations, it is impossible to estimate correctly the quantity formed daily; which has been differently estimated at from 7 ozs. to 16½ lbs.

Whilst, therefore, discrepancies exist in the statements of different physiologists concerning the actual amounts of gastric juice, bile and pancreatic juice secreted during specific periods; and whilst the collection of these fluids by the aid of artificial fistulæ in animals, is open to the objection, that the conditions, especially of the nerves which govern the quantity of the secretion are not healthy; and whilst objections may be raised against those estimates based upon calculations of the probable quantity, by collecting the juice for a certain time and multiplying the quantity thus obtained by a number representing the whole twenty-four hours, on the ground of the intermittency of the secretions; at the same time it is evident that the total quantity of the digestive fluids poured into the alimentary canal after taking food, is much greater than was formerly supposed, and in comparison with the blood circulating in the body is very great, and that the phenomenon of absorption by secretion in the living animal can be only very imperfectly illustrated by experiments upon dead animal membranes.

In experiments upon membranes removed from the bodies of animals, it is absolutely impossible to fulfill the conditions performed by the constantly moving currents of blood, and by the nervous and muscular forces, and by the development, nutrition and constant metamorphoses of the individual morphological elements. The important phenomenon, first fully illustrated by Graham, under the term *dialysis*, viz: that various membranes and some porous septa, will allow only crystalloid bodies to pass through, while the organic, or in the language of Graham, the Colloid substances are retained, must also be modified by the constant changes taking place in living tissues, and such modifications must be attended with corresponding variations of the osmotic currents.*

The fact that all living tissues are capable of selecting and appropriating from the nutritive fluids the materials necessary for the regeneration of their morphological constituents, and that the secreting structures of glands select from the blood the materials used in the formation of their secretions, and that the nutrition of the tissues and the character of the secretions may be modified through the nervous syetem, cannot as yet be fully explained by physical experiments, although much light has been undoubtedly thrown upon such phenomena, by the investigations of Nollet, Lebküchner, Magendie, Dutrochet, Parrot, Porrett, Fischer, Liebig, Mialhe, Graham, and others. Some of the modifications which absorption undergoes in the living economy, evidently, can only be explained by the supposition, that the liquids and the substances which they hold in solution, become for the time, part of the living structures, and partake of their peculiar properties.

Derangements of the due relationship of secretion to absorption in the tissues and cavities of the body, may depend upon—

1st. Derangements in the nutrition of the tissues, leading either to an increase of secretion or a diminution of absorption.

2d. Derangements or alterations of the blood, leading to derangement of the nutrition of the tissues, with an increase of secretion or diminution of absorption.

3d. Derangements of the circulatory apparatus, attended with venous obstruction and congestion, increased serous effusion from the distended blood-vessels, and diminished absorption.

4th. Derangement of the functions of those organs, which regulate the amount of the blood, as well as the constitution, by regulating the amount of the watery element, and by the elimination of excrementitious materials.

It is important that the student should bear in mind the distinction between *transudations* and *exudations:*

Transudations are not, properly, liquor sanguinis, although derived from the blood, but consist of water containing more or less of the constituents of the serum of the blood—the salts and albumen—without any appreciable amount of the fibrin or coagulable element. They, therefore, preserve the liquid state; and the act of transudation relates chiefly to the physical properties of the tissues.

In transudation, there is no solution of continuity or rupture, the watery portion of the serum of the blood simply percolating through the porous walls of the blood-vessels;

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* It is well known that in the living animal, there is a preponderance of the so-called *endosmotic* current, whilst there is little or no transudation, or *exosmosis* of albumen, the chief nutritive constituent of the blood, except into the lymphatic system, which, as we have seen, has been shown by recent researches, to be possessed of distinct stomata, which anatomical arrangement may be supposed to be adapted especially to the entrance of the albuminoid serous fluid of the tissues. *Albuminose* on the other hand, is constantly absorbed in the alimentary canal, and transformed into the albumen of the blood. Mialhe has given an explanation of this remarkable phenomenon, by establishing the different endosmotic properties of albumen and albuminose. Recognizing the fact pointed out by Dutrochet, that albumen is capable of inducing a more powerful endosmotic current, than almost any other liquid he has shown, that it never itself passes through membranes, in the so-called exosmotic current; but that albuminoids, after transformation by digestion into albuminose, or albumen mixed with gastric juice, pass through animal membranes with great facility. Such facts render it evident that slight physical or chemical changes in the constitution of organic substances, may be attended by the most marked changes in their osmotic powers.

No distinction therefore, can be drawn between the so-called crystalloid and the so-called colloid bodies based entirely upon their osmotic properties, as slight physical and chemical changes may render the *colloid* as readily osmotic and diffusable as the *crystalloid.*

and transudation is usually the result either of a diminution of the albuminoid elements and salts of the serum of blood, or of undue hydraulic pressure, or of both causes combined. Effusions, or exudations, devoid of fibrin and cytoblasts, and incapable of organization, when retained, are characteristic of dropsy. Occurring upon mucous surfaces which communicate with the exterior, they constitute *fluxes*.

Exudations contain, on the other hand, fibrin and cytoblasts or germ cells, and are capable of coagulation and organization. Exudations are the result of inflammation, whilst in true dropsy this morbid process is wanting.

Inflammation of serous membranes may be attended with more or less effusion, but the liquid is turbid from the admixture of coagulable lymph, and in this respect differs from the clear serous liquid of true dropsy.

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CHAPTER XI.

DROPSY ARISING FROM DERANGEMENTS IN THE NUTRITION OF THE TISSUES, LEADING EITHER TO AN INCREASE OF SECRETION, OR DIMINUTION OF ABSORPTION.

SUDDEN ACCUMULATION OF FLUID IN THE PERITONEUM. RESEARCHES OF ANDRAL, BECQUEREL AND RODIER, ON THE CAUSES OF ACUTE DROPSY. CONSTITUTION OF THE BLOOD IN ACUTE DROPSY. TREATMENT OF ACUTE DROPSY.

This division is placed first, not only because it should include the most simple and uncomplicated cases of dropsy, but also because the progress of pathological anatomy and chemistry during the past thirty years, has greatly modified the ideas, formerly entertained respecting dropsy, and the class of dropsies long regarded as idiopathic or essential, has become so restricted, as almost to have disappeared from nosological classifications. Some pathologists have so far restricted the causes, as to admit only two species of dropsy, viz: the so-called mechanical dropsies, the result of an obstacle presented to the flow of blood, whether in the central organ of the circulation, or in a vascular trunk of a certain size; and dropsies symptomatic of a special modification of the blood, consisting exclusively in a decrease in the proportion of the albumen to the serum.

The question involved in the preceding division, does not appear to have been definitely settled; and even in the apparent simple form in which it is now stated, important questions relating to the process of secretion and nutrition, and the connection of the blood with these acts are involved.

Cases of dropsy are not infrequently observed, both in hospital and private practice, which are for the most part acute, and in which no trace of albumen is found in the urine, and the dependence of which, upon some alteration of the blood, or derangement of the action of the kidneys, has not been fully established.

Sir Thomas Watson has described a form of dropsy, which he calls *active ascites*, where fluid is rapidly thrown out into the peritoneum and cellular tissue of the extremities, after exposure to cold and wet, without fever, or any sign of inflammation, and independent of any disease of the heart, liver or kidneys; and where, after a short time, the fluid is again absorbed. And he gives the following as a typical case of the phenomena of active dropsy; a laborer is engaged in some employment, which, while it requires considerable bodily exertion, and causes copious perspiration, necessarily exposes him also to the influence of external cold and moisture; he has been digging (perhaps) in a wet ditch, in winter time, and he pauses to take his meal; or he has been unloading his wagon, and rides home, some miles, in a heavy rain that wets him to the skin; or he has been mowing in the heat of summer, and lies down to sleep upon the damp grass. All these suppositions are derived from actual occurrences. The perspiration is suddenly checked; and in the course of a few hours he becomes universally anasarcous. Sir Thomas Watson explains the sudden occurrence of dropsy in such cases, by the sudden check of the exhalation of water from the skin and kidneys, lungs and bowels. But supposing the exhalation from one of these surfaces to be much diminished, or to cease, without a corresponding increase of function in the related organ, or in any excreting organ communicating with the exterior, then dropsy, in some form or degree, is very apt to rise. The aqueous liquid thus detained in the blood-vessels, seeks, and at length finds some unnatural and inward vent, and is poured forth into the areolar tissue, or into the cavities bounded by the serous membranes.

Dr. Charles Murchison, in his Clinical Lectures on Diseases of the Liver, J and Abdominal Dropsy, has recorded the following interesting case of what termed acute dropsy.

Case 634: *Symptoms of Colic, followed by signs of Fluid in the Peritoneum.*—Edw aged twenty-one, who had formerly been a printer, but had been working for si at a carver and gilder's, was admitted into the Middlesex Hospital, under my care, on 12, 1868. On April 6, he had been suddenly seized with severe pain in the abdom retching. The pain had been constant ever since, but had been also liable to some exa tions. The vomiting had recurred daily, but had not been so violent as at first. The had acted on the 8th and 10th, after castor oil and laudanum. Shortly before his attack, patient had been suffering from gonorrhœa, and stated that some years before he had a though much less severe attack of abdominal pain.

On admission, the patient complained of constant pain in the abdomen, with frequent exacerbations. The pain was increased by any movement, and there was also consider derness over the abdomen, most marked over the cæcum. The abdomen was distended tympanitic, and the breathing was entirely thoracic. There was frequent retching of bilious matter. There was a dark red (not blue) line along the margin of the gums. tongue was moist, and only slightly furred; there was thirst, and the bowels had not opened for two days. The pulse was 84; the skin was cool, and the temperature under tongue 97°. There was no albumen in the urine.

The patient was ordered a warm bath, warm fomentations to the belly, an enema of pints of barley water with four drachms of tincture of assafœtida, and a grain of opium four hours.

The enema brought away two copious motions, but with no relief to the pain. 13th, a third of a grain of extract of belladonna was ordered every three hours, but the pain, tenderness and tension of the abdomen had increased, although the pulse was 72, and the temperature 97°. He was again ordered a grain of opium every four draught of castor oil and laudanum, and frequent enemata. He also continued taking grains of opium a day, until April 17th, and then three grains until April 23d. Under treatment the bowels were freely moved, and the paroxysms of pain became less severe; still he had occasional vomiting, the abdomen grew larger and more tense, and on April there was unmistakeable evidence of fluid in the peritoneum. A thrill could be pro from one side to the other, on tapping, and where the patient was supine, there was on either flank, which varied with his position. He still had occasional paroxysms of but no tenderness of the abdomen. The pulse, however, kept steadily at 72, and the perature rarely exceeded 98°. The signs of fluid in the peritoneum, with occasional paroxysms of pain continued until May 4th. After this, the abdomen gradually smaller, and on May 18th, it had regained its normal size, and presented no sign of fluid, the patient left the hospital free from pain.

The researches of Andral, Becquerel and Rodier, render it probable that in cases of acute dropsy, there is oftimes, if not always, in the early stages, a congestio the kidneys, with the appearance of albumen in the urine.

Andral, after noticing the fact that sometimes individuals, who, after exp some sudden cause of cold, are attacked a few hours after with anasarca, states after accounting for the dropsy, by supposing that the sudden suppression of the neous function of transpiration rapidly produced a superabundant exhalation of into the areola of the cellular tissue and the serous cavities, he was led to conclude this kind of dropsy was dependent upon derangement of the kidneys.

A young man, previously in good health, and strongly constituted, entered the pital of La Charité, with considerable anasarca and commencing ascites. He Andral, that a few days before, being abed and asleep, some of his comrades upon him a pot of cold urine, while he was in a state of perspiration. He naked in order to pursue them, and was very much chilled; he remained, said he, as frozen. From the day following this occurrence, he began to perceive a slight of swelling, which rapidly augmented. The urine of this patient was examined, found to be albuminous. Andral concluded from this, that the blood had been by the kidneys of a certain amount of its albumen, and in this way accounted formation of the dropsy. *It is then upon the kidneys that the action of the fallen.* This dropsy was not, moreover, of long duration; at the end of a cure was complete.

Becquerel and Rodier, in their pathological chemistry, have given the results of the analysis of the blood in eleven cases of *acute dropsy*.

The following is the *historical* resumé, which these authors give to establish the dependence of acute dropsy upon some alteration of the blood, although this dependence was proved merely by induction.

"Nine of the patients were males, and two were females. In all, the disease set in rapidly, under the following circumstances:

"In one case it followed a sudden suppression of the catamenia from violent emotion; in a second, it occurred at the fifth month of pregnancy, but without any very appreciable cause; in a third, it followed an attack of scarlatina; in four other cases, it followed a long exposure to cold; in another, it resulted from sleeping on the ground in the open air, during the month of June; lastly, in three cases, the cause was inappreciable. In two of these latter, the patients were suffering from a relapse of the disease.

"Of these eleven patients, nine entered the hospital before the fourth, or after the eleventh day of the disease.

"The primary phenomena were not the same in every case. In six, dropsy was the only symptom; in two, it was accompanied by fever; in two others, there was likewise a slight amount of fever, with vomiting and diarrhœa; while in another, there was vomiting, coupled with an attack of jaundice.

"On the admission of the patients into hospital, the only marked symptom was general anasarca of varying intensity, from slight, but diffuse puffiness of the integuments, up to a considerable infiltration of the sub-cutaneous cellular tissue. The skin was, as a rule, somewhat paler than usual. The remaining organs, and even those which had been affected at the outset of the disease, were in a healthy condition. The feverish symptoms had likewise disappeared. In nine of these patients the urine presented no trace of albumen, either on their entrance into, or during their whole stay in the hospital; it was perfectly natural, moreover, both as regards quantity and chemical composition. In two cases, however, the following phenomena were observed: In one man, who was admitted on the fourth day of the disease, a considerable amount of albumen was found in the urine on that and the succeeding day; on the sixth and seventh day it had gradually diminished; on the eighth, it was barely discernible, and on the ninth day it had entirely disappeared. The dropsy, however, was not removed until the seventeenth day. In the second case, admitted on the fifth day of the disease, a small quantity of albumen was found on the sixth and seventh day of the disease, but none whatever on the eighth.

"Of these eleven cases, nine were cured, and two left the hospital relieved. In none did the disease last longer than a month.

"An analysis of the blood was made in each of these cases, and the mean results thus obtained, will be found in the subjoined table:

Analysis of 1000 *Grammes of Blood.*

	Mean.	Maxim'a.	Minim'a.
Specific gravity	1045.84	1053.20	1037.55
Water	830.78	....	....
Globules	104.58	134.88	70.10
Solid matters of the serum	61.87	65.62	57.24
Fibrin	2.67	4.10	1.25

Analysis of 1000 *Grammes of Serum.*

	Mean.	Maxim'a.	Minim'a.
Specific gravity	1022.61	1024.28	1020.05
Water	928.47	....	....
Albumen	58.52	63.18	51.12
Extractive matters and salts	13.01	17.14	7.74

"*The globules* are less liable to decrease than in cachetic dropsy; they nevertheless fell, in one case, to 70, and in another to 72. In three cases they were about 120 per 1000; in three others, between 100 and 120; and in five cases, between 100 and 110.

"*The fibrin* underwent a marked diminution in two cases only, viz: between 1 and 2 per 1000; in six cases it varied from 3 to 6, while in three others it rose above 3 per 1000.

"*The albumen of the serum* was always diminished, and in some instances this diminution was considerable; it ranged from 60 to 66 in four cases, and from 55 to 60 in six others, while in one case it fell as low as 51.02.

"It is almost needless to add that the specific gravity of both the blood and serum was always found to have fallen below the standard of health.

“Such, then, is the history of acute dropsy. We have now to interpret and explain its attendant phenomena.

“At first, two prominent facts present themselves to our notice; the one being the dropsy, and the other a modification of the blood, consisting in a decrease of the albumen, and of the specific gravity of the circulating fluid itself.

“What is, then, the correlation of these two facts? Upon which of the two does the other depend, or are they independent of each other? To answer such questions, is somewhat more difficult than might be *a priori* imagined. If, in fact, we admit that the alteration of the blood precedes the dropsy, how are we to explain the decrease of the albumen in those cases where there has not existed (as in cachetic dropsy) any material appreciable cause, to account for the impoverishment of the vital fluid? This difficulty, however, is not insurmountable, and the following simple explanation may perchance prove satisfactory:

“Of the eleven cases quoted above, two were admitted before the seventh day of the disease.

“What, then did we find in these two cases? An expiring albuminuria, if we may be permitted to use such an expression. On admission, a certain amount of albumen is found in the urine, its decrease is watched, and about the eighth day it is found to disappear entirely. In such a case, the modification of the blood admits of easy explanation.

“It is evident, in fact, that the following sequence of events took place: These two individuals, whether under the influence of cold, or some other cause, were attacked with a certain amount of congestion of the kidney. This congestion was manifested by the escape of albumen along with the urine, which lasted as long as the congestion itself, viz: seven or eight days, and then ceased. Under the influence of this escape of the albumen, the proportion of that element naturally existing in the blood became diminished, the density of the serum fell, and dropsy was produced. But the change in the composition of the blood, when once effected, lasts for some time after the disappearance of the albumen from the urine, and as long as this change exists, so long will the dropsy likewise exist. Had these two patients not been seen until the eighth day of the disease, no albumen would have been found in the urine; the diminished amount of that constituent existing in the blood, together with the dropsy, could alone have been discovered, and their correlation would have been lost.

“In these two cases this solution of the problem would appear simple and rational, nor do we think it can well be contested. But will it hold good with respect to the remaining nine cases? We think it will; and we admit the same, by induction it is true, but yet upon certain plausible reasons, which are the following:

1. As these nine cases were not admitted into the hospital until after the seventh day of the disease, we may readily conceive the albumen to have disappeared from the urine previous to admission.
2. The symptomatic expression of the disease was the same in every case. In several of them its onset was marked by a combination of phenomena sufficiently characteristic of acute congestion of the kidney (active hyperæmia).
3. The modification of the blood was the same in each of the eleven cases.
4. The progress and duration of the disease were likewise identical in each.

“We may now, therefore, offer the following summary of our theory; for however rational and satisfactory, it is still but a theory:

“Under the influence of some cause or other, congestion of the kidney is produced. The congestion is indicated, along with other symptomatic phenomena, by the escape of a certain amount of albumen with the urine; this, ere long, diminishes the natural proportion of the albumen of the blood, and the latter condition in its turn gives rise to a greater or less degree of dropsy. We may here observe that, when this decrease of the albumen takes place rapidly, dropsy is produced with greater facility and with less diminution on the part of this constituent of the blood, than when it occurs in a chronic form. But the congestion of the kidney is generally of much shorter duration than the modification of the blood and its consecutive dropsy; it disappears therefore long before these latter phenomena, and if the patients are not examined until a certain time after the onset of the disease, they alone are observed, the escape of albumen with the urine having altogether ceased.

“If the theory which we have thus propounded be the true one, it would seem advisable to designate the disease in question, as congestion or active hyperæmia of the kidney, rather than as acute dropsy from decrease of the albumen of the blood. We do not, however, deem ourselves authorized to make such a change, being unable, as yet, to elevate our hypothesis to the rank of a positive fact, at least in the majority of cases.”

These investigations of Becquerel and Rodier, conducted in the spirit of Philosophic inquiry, are of great value, in establishing the connection of acute dropsy with congestion of the kidneys. It would be more reasonable to suppose that the accompanying dropsical effusion was as much the result of the non-elimination of the elements of the urine, and the retention of the watery element, as the mere loss of albumen. I have witnessed the supervention of acute dropsy in patients who were exposed to cold, during convalescence from chicken pox, measles and scarlatina, within two days after the cause which produced congestion of the kidney, with almost complete cessation of its action. In such cases, the two or three ounces of urine excreted during the twenty-four hours, although loaded with albumen, were not sufficient in quantity to materially affect the composition of the blood. The most sudden case of acute dropsy, that I have ever witnessed, was attended with almost complete suppression of urine, as the result of exposure to cold during convalescence from variola; and uremic convulsions of the most violent character supervened.

The retention of the urea, and water normally excreted by the kidneys, appears to be connected with the dropsical effusion, even more intimately than the loss of a small amount of albumen.

The treatment of acute dropsy should be based upon an accurate knowledge of the previous state of the patient and the amount and composition of the urine.

When the kidneys are congested, and the urine is scant and loaded with albumen, and the patient suffers with fever, general uneasiness and gastric derangement, both general and local blood-letting may be practiced with benefit.

Leeches and cut-cups over the region of the kidneys will prove beneficial in relieving the congestion. After the albumen has disappeared from the urine, and in those cases in which its presence has been never detected, blood-letting is not indicated.

The diet should be light but nutritious, and composed largely of vegetable and farinaceous articles.

Various measures may be instituted to procure the removal of the effused fluid; as purgatives, hot air baths, diuretics and stimulating frictions.

When the kidneys are congested, *stimulating* diuretics should be avoided, and the *saline* diuretics should be employed. The bitatrate of potassa (cream of tartar), employed in the proportion of one ounce dissolved, or rather suspended in one pint of the infusion of juniper berries (juniperi fructus), may be administered during the twenty-four hours. If the gentle stimulant effect of the volatile oil and resin of the juniper berries be contra-indicated, the cream of tartar may be given suspended in one pint of water. A wine glassful of this mixture may be taken every two or three hours. After the relief of the kidneys, and the establishment of the excretion of the urea in its normal amount, good diet, together with tonics, especially cinchona and the vegetable bitters, may be employed to restore the blood to the normal standard.

CHAPTER XII.

DROPSY ARISING FROM DERANGEMENTS OR ALTERATIONS OF THE BLOOD, LEADING TO DERANGEMENT OF THE NUTRITION OF THE TISSUES, WITH AN INCREASE OF SECRETION OR A DIMINUTION OF ABSORPTION. EFFECTS OF THE PROLONGED ACTION OF THE MALARIAL POISON IN DERANGING THE CONSTITUTION ;OF THE BLOOD, AND IN INDUCING DROPSY. CONSTITUTION OF THE BLOOD IN MALARIAL FEVER. CONSTITUTION OF THE BLOOD IN MARSH CACHEXIA. TREATMENT OF DROPSY ARISING FROM THE ACTION OF THE MALARIAL POISON.

THE prolonged action of the malarial poison, not unfrequently induces such changes in the composition of the blood and such derangements of the liver and spleen, as to lead to the effusion of serous fluid into the areolar tissue and peritoneum. The changes of the blood induced by Malarial Fever, appear to be the chief cause of the dropsical effusions, although in some cases this symptom may be attributed to the mechanical obstacle, offered by the enlarged spleen and liver. Several well marked cases of dropsy resulting from the prolonged action of the malarial poison have been from time to time presented to the Medical Class of the University of Louisiana, in which no albumen could be detected in the urine, nor any diminution of this secretion, nor any very great enlargement of the liver and spleen. Such cases were uniformly characterized by a sallow, anæmic complexion, and watery blood, poor in solid constituents. The effects of the malarial poison in altering the composition of the blood, are shown in the following table (page 585), embodying the results of my investigations:

The effects of the malarial poison upon the blood, are rendered manifest, by a comparison with the following typical formula of the constitution of the blood.

Physiological limits of the variations of the constituents of the blood as established by the researches of MM. Becquerel and Rodier:

IN 1000 PARTS OF BLOOD

The water, may vary	from	760.00	to	800.00.
The specific gravity may vary	"	1055.00	to	1063.00.
The globules may vary	"	120.00	to	150.00.
The fibrin may vary	"	2.00	to	3.50.
The solid matters of serum may vary	"	90.00	to	105.00.
The saline constituents may vary	"	4.00	to	10.00.

IN 1000 PARTS OF SERUM.

The specific gravity of serum may vary	from	1027.00	to	1032.00.
The water of serum may vary	"	880.00	to	900.00.
The solid matters may vary	"	100.00	to	120.00.
The albumen may vary	"	70.00	to	90.00.

The following is the typical formula of the constitution of the Blood in health, adopted by MM. Becquerel and Rodier.

ANALYSIS OF 1000 PARTS OF BLOOD

Specific gravity of blood	1060.00
Water	781.60
Globules	135.00
Albumen	70.00
Fibrin	2.50
Fatty Matters, Extractive Matters and free Salts	10.00
Phosphates	0.50
Iron	0.25

Table illustrating the changes of the Blood in Malarial Fever, from Investigations and Analyses by Joseph Jones, M. D., Professor of Chemistry and Clinical Medicine, Medical Department University of Louisiana.

	Intermittent Fever of 12 days' duration at time of analysis. Male.	Intermittent Fev'r of 2 weeks' durationat time of analysis. Male.	Intermittent Fev'r of 6 weeks' duration. Male.	Remittent Fever of 16 days' duration at time of analysis. Male.	Remittent Fever of 10 days' duration at time of analysis. Male.	Remittent and Typhoid Fever of 11 days' duration at time of analysis. M.	Remittent Fever of 2 weeks' duration. Male.	Congestive Fever. Male.	Congestive Fever. Male.
	78	79	80	81	82	83	84	85	86
1000 Parts of Blood contained:									
Moist Blood Corpuscles	413.73	293.62	207.94	407.76	431.50	262.44	309.93	317.74	343.87
Water of Moist Blood Corpuscles	310.21	220.21	155.86	306.82	323.63	196.83	232.45	238.27	258.80
Organic Matters of Moist Blood Corpuscles	100.43	70.41	51.81	100.40	107.32	62.70	73.65	76.00	84.40
Mineral Matters of Moist Blood Corpuscles	3.00	2.96	0.17	1.43	0.49	2.79	3.77	3.40	0.56
Liquor of Sanguinis	586.26	706.38	792.05	592.23	568.49	737.55	690.06	682.25	656.12
Water of Liquor Sanguinis	520.21	630.70	721.69	525.47	504.27	664.14	607.12	602.24	574.64
Organic Matters of Liquor Sanguinis	58.32	68.40	65.19	61.50	59.21	66.40	76.38	76.70	74.18
Mineral Matters of Liquor Sanguinis	4.76	4.73	3.14	2.30	3.55	4.52	3.73	2.38	5.74
Fibrin	1.90	2.54	1.92	2.93	1.43	2.38	2.71	0.87	1.45
1000 Parts of Moist Blood Corpuscles contained:									
Water	749.99	750.00	749.51	750.00	750.00	750.00	750.22	749.87	752.64
Organic Residue	242.74	239.80	249.15	246.46	248.70	239.29	237.64	239.28	245.23
Mineral Matters	7.25	10.08	0.84	3.51	1.11	10.64	12.13	10.72	1.64
Solid Matters in 1000 parts of Blood	169.49	149.11	122.44	168.70	172.09	139.02	160.41	159.48	166.55
Solid Matters in 1000 parts of Serum	70.71	79.18	72.24	72.14	71.63	76.21	87.22	86.05	87.61
Solid Matters in Serum of 1000 parts of Blood	64.15	73.16	68.43	64.46	62.78	71.03	80.22	79.13	80.03

ANALYSIS OF 1000 PARTS OF SERUM.

Specific gravity of serum	1028.00
Water	908.00
Albumen	80.00
Extractive Matters and free Salts	12.00

The following results are established by this comparison:

1. In Malarial Fever the specific gravity of the blood and serum is diminished.

The specific gravity of the blood ranges in this disease from 1030.5 to 1042.4, and the specific gravity of the serum from 1018. to 1023.6.

In health, on the other hand, the specific gravity of the blood varies from 1055. to 1063., and the specific gravity of the serum from 1027. to 1032.

2. In Malarial Fever the colored blood-corpuscles are greatly diminished.

In health the dried corpuscles may vary from 120. to 150. parts in the 1000 of blood, and the moist blood-corpuscles from 480. to 600. In Malarial Fever, on the other hand, the dried colored corpuscles range from 51.98 parts to 107.81; and the moist blood-corpuscles from 207.92 to 323.63.

The careful comparison of these analyses of malarial blood with each other, reveals the fact, that the extent and rapidity of the diminution of the colored corpuscles, corresponds to the severity and duration of the disease. A short but violent attack of congestive or of remittent fever, in its severer forms, will accomplish as great a diminution of the colored blood-corpuscles, as a long attack of intermittent fever, or the prolonged action of the malarial poison.

3. In Malarial Fever the relation between the colored corpuscles and liquor sanguinis is deranged.

Thus in healthy blood the relative proportions of moist blood-corpuscles in the 1000 parts and liquor sanguinis, may vary from 480.00 to 600.00 of the former, and from 520.00 to 400.00 of the latter; whilst in Malarial Fever, the globules vary from 207.92 to 323.63, and the liquor sanguinis from 792.08 to 676.37.

4. The Fibrin of the Blood is diminished to a marked extent, in some cases of Malarial Fever, and is altered in its properties and in its relations to the other elements of the blood, and to the blood-vessels.

5. The Organic matters of the Liquor Sanguinis, and especially the Albumen, is diminished in Malarial Fever.

Thus the solid matters of the serum may vary in health, from 90.00 to 105.00; whilst in Malarial Fever, they vary from 62.78 to 80.22 parts, in the 1000 parts of blood.

It is chiefly to this latter change, viz: the diminution of the albumen of the blood in Malarial Fever, that the dropsical effusions are to be traced. The other changes of the blood, without doubt, lead to congestions of the liver and spleen, and to derangements of the capillary circulation and nutrition of the organs and tissues, but a careful examination of those diseases as anæmia, chorea and pyæmia, in which the colored blood-corpuscles are greatly diminished, will show that this cause alone will not induce dropsy. In the watery state of the blood induced by the action of the paludal poison, comparatively slight obstructions of the circulation in the spleen and liver might lead to dropsical effusion.

It would appear also, that from the derangement of nutrition caused by the action of the malarial poison upon the blood and nervous system, that certain effete products are not sufficiently and properly eliminated, and then as in the case of urea, may be active in the production of dropsy.

MM. Becquerel and Rodier have demonstrated that in that peculiar condition of the system called marsh cachexia, accompanied by a remarkable decloration of the skin, and not unfrequently by dropsy, and produced by the long influence of malaria, there is the greatest decrease of both the albumen and the globules; as is well shown by the following analysis of marsh cachexia.

Analysis of 1000 *parts of Blood in Marsh Cachexia.*

	A man, aged 50, suffering from Marsh Cachexia and Gen'l Dropsy.	A man, aged 48, suffering from Marsh Cachexia and Gen'l Dropsy.	A man, aged 48, suffering from Marsh Cachexia and Gen'l Dropsy.	A man, aged 21, suffering from Marsh Cachexia and Gen'l Dropsy.	A man, aged 18, suffering from Marsh Cachexia and Gen'l Dropsy.
Specific Gravity	1035.40	1040.00	1034.06	1033.85	1040.57
Water	869.34	853.75	869.71	875.67	846.31
Moist Globules	268.40	407.48	269.12	224.88	378.88
Solid Matters of Moist Globules	67.10	101.87	67.28	56.22	87.22
Water of Moist Globules	201.30	305.61	201.84	168.66	251.66
Solid Matters of Serum	61.10	41.84	59.88	63.83	62.32
Fibrin	2.36	2.54	3.13	4.27	4.15

Analysis of 1000 *Parts of Serum in Marsh Cachexia.*

Specific Gravity	1020.37	1016.40	1021.61	1024.15	1023.56
Water	936.40	953.29	930.08	926.75	922.98
Albumen	55.68	37.26	50.20	60.20	63.25
Extractive Matters and Salts	7.92	9.45	13.72	13.05	13.77

The mean composition of the blood in marsh cachexia may be represented thus:

Anvlysis of 1000 *parts of blood (mean composition of in five cases of Marsh Cachexia.)*

Specific gravity	1036 76
Water	962 38
Moist globules	303 76
Dried residue of globules	75 95
Water of globules	227 82
Solid matters of serum	57 79
Fibrin	3 39

Mean composition of 1000 *parts serum.*

Specific gravity	1021 22
Water	935 10
Albumen	53 32
Extractive matters and salts	11 58

The following interesting remarks with reference to the cause of the dropsy, are made by MM. Becquerel and Rodier:

> "The dropsy has been attributed to the mechanical obstacle afforded by the enlarged condition of the spleen, so common in these cases. We do not deny the possibility of such a sequence; but it is certain that in many instances, we fail to discover such an amount of splenic enlargement, as would suffice to explain the occurrence of an increasing and general anasarca. In only one of the preceding analysis of the blood, in marsh cachexia, did we notice a marked degree of splenic enlargement; it was, however, insufficient to account for the serous infiltration. * * * * *
>
> "It is in this disease, therefore, that we meet with the greatest decrease of both the albumen and globules. It may be taken as the type of cachectic dropsy.
>
> "How now, are we to account for so great a change in the composition of the blood? We are driven to admit a poisoned condition of this fluid, produced either by the absorption of the marsh miasm, or by repeated attacks of the peculiar fevers to which this miasm gives rise?"

The indications in the treatment of dropsy arising from the action of the malarial poison, are:

1st. The removal of the cause, giving rise to the phenomena of malarial fever, and causing a simultaneous decrease of the globules and albumen, with congestion of the liver and spleen. The patient must be removed from the influence of the paludal poison. In many cases, even after the removal of the patients to elevated, healthy non-miasmatic regions, the attacks of ague wiil recur again and again with obstinacy.

2d. The prevention of the recurrence of the malarial paroxysms, and the removal, neutralization or elimination of the cause. This indication may be fulfilled by the persistent use of cinchona, in various forms, and especially sulphate of quinia. To prevent the recurrence of the paroxysm, quinine should be given in doses varying from five to ten grains every two or three hours, until from twenty to thirty grains have been taken before the time of the expected paroxysm. In the intermission, and in fact throughout the continuance of the dropsy, the patient should be kept gently under the influence of quinine, from two to four grains being administered three times a day. The iodide of quinia (from one to three grains dissolved in a wineglass of water,) has proved highly beneficial in my hands in such cases. As the blood is impoverished, good results are obtained by giving iron in combination with the sulphate of quinia.

3d. The removal of the dropsical effusion. This will best be accomplished by the judicious use of purgatives, diuretics, the hot air bath, and stimulant frictions of every kind, as dry friction, and aromatic, alcoholic and ammoniacal frictions.

Purgatives judiciously used not only cause absorption of the serous effusion, but they also diminish the congestion of the liver and spleen. The blue pill (pilulæ hydrargyri,) in doses of from five to ten grains, occasionally may be administered with marked benefit. The cream of tartar and juniper berry infusion is one of the best diuretics in such cases.

In the employment of purgatives and diuretics, great care should be exercised not to exhaust the patient, nor to weaken and derange the digestive function.

If possible, we should avoid impoverishing the blood further by the use of these remedies.

In many cases, the free perspiration induced by the hot air bath will prove of essential benefit.

4th. The improvement of the blood. Nitrogenized food, especially good beef-steak, if the digestive powers are sufficiently strong, fresh milk, and soft boiled eggs, with a moderate quantity of generous wine, will tend, not only to improve the digestive powers, but also to furnish the materials for healthy, rich blood.

The digestive powers and the nervous system may, in like manner, be invigorated, by the use of the vegetable bitters, and especially of gentian, and strychnine. It is best to administer the strychnine in doses of one twentieth of a grain dissolved in water acidulated with citric acid. In many cases it is found, that the dropsical effusion diminishes just as the blood recovers its normal composition.

Iron is almost universally indicated, by the marked decrease of the blood globules, and on account of its valuable effects in restoring the digestive function. One of the best combinations in such cases, is a pill composed of three grains of precipitated Iron, (iron by hydrogen,) two grains of sulphate of quinia, and one grain of the extract of rhubarb. The extract of rhubarb is used in proportions just sufficient to overcome the astringent effects of the iron. This pill may be taken three times a day and persevered in for weeks and months. In this combination, we likewise obtain the prophylactic action of quinia.

The cure of this form of dropsy is tedious and prolonged in most cases, and the iron and bitter tonics should be used with perseverance.

5. Hygienic Measures. A healthy, well ventilated residence in an elevated non-malarious region, gentle but regular exercise in the open air, and the wearing of warm clothing, as flannel next to the skin, are valuable adjuvants to treatment.

Dropsy may also arise from the changes of the blood, induced by insufficient and salt food (as in scurvy,) by repeated hæmorrhages (as the hæmorrhoidal flux;) by chronic diarrhœa, and by the effects of the absorption of cancerous matter.

In the great Valley of the Mississippi, a large proportion of the cases of dropsy which occur, both in Hospital and Private Practice, are directly traceable to the prolonged action of Malaria, which induces profound alterations in the blood, destroying the colored corpuscles and fibrin, thus deranging the normal relations between the solids and fluids; and at the same time producing important and serious lesions of the liver and spleen, attended with obstructions in the portal, splenic and intestinal circulation.

The extent to which malaria prevails in the Mississippi Valley, is clearly shown by the mortuary statistics of New Orleans, and by the annual reports of the Charity Hospital, which receives vast numbers of patients from all the States tributary to the Mississippi River, and to New Orleans as a great commercial centre, and shipping port.

The relation of paroxysmal, paludal malarious disease, to the other forms of disease, is well shown by the following statistics:

During a period of 45 months active service in the Charity Hospital, of New Orleans, (distributed as follows: January 1st, 1869, to April 1st, 1870; October 1st, 1870, to April 1st, 1871; October 1st, 1871, to April 1st, 1872; October 1st, 1872, to April 1st, 1873; October 1st, 1873, to April 1st, 1874; October 1st, 1874 to April 1st, 1875,) I treated *two thousand three hundred and eighty*, (2,380) cases of various diseases, with a total mortality of 235 deaths from all causes.

During the period specified, the mortality in the cases of various diseases treated by me in the wards of the Charity Hospital amounted to 9.83 per cent, or in the ratio of one death in 10.12 cases.

Of the total number of cases treated, Intermittent Fever numbered 725 cases, all of which were relieved and discharged without a single death; Paroxysmal Fever of long standing, in which such profound lesions had been produced in the blood, liver and spleen, as to induce ascites and anasarca numbered 54 cases, with 6 deaths; Pernicious or Congestive Malarial Fever, numbered 31 cases, with 17 deaths; (the fatal cases without an exception, having entered the hospital insensible and comatose, and often in articulo mortis, the character of the disease being verified in such cases by post-mortem examinations;) Remittent Fever 82 cases, with 1 death; Malarial Hæmaturia, 4 cases, with 2 deaths. Total cases of undoubted paroxysmal malarious paludal diseases directly traceable to malaria, 896: total deaths, 26.

Per cent of deaths in cases of malarious diseases, 2.9.

Ratio of deaths to cases of malarious disease, one death in 34.46 cases.

A large number of the remaining diseases, 1484, were more or less under the influence of malaria, and were to a greater or less extent complicated by it. This was especially true of such diseases as Pneumonia, Pleuritis, Rheumatism and Organic Diseases of the circulatory apparatus, of the digestive apparatus, and of the liver, spleen and kidneys.

Whilst therefore the mortality attributable to the direct action of the malarial poison was comparatively slight, owing most probably to the efficient and persistent use of Quinine, Bark, Iron and Bitter Tonics, combined with supporting treatment and nutritious diet, it appears that the progress of other diseases was influenced by the pre-existing and accompanying action of malaria.

During the fall of 1870–71, I treated in my wards in the Charity Hospital, a larger number of dropsical cases than usual; a considerable proportion of the patients who entered with the various forms of malarial fever, and more especially with obstinate Intermittents, and with chronic malarial poisoning, were suffering with more or less anasarca and œdema. When there was no serious or malignant disease of the liver, kidneys or heart, these cases of dropsy recovered under the use of Quinine, Iron, Arsenic, Cream of Tartar, and Blue Mass. Great benefit was derived in some of these cases, after the bowels had been properly regulated, by a combination of Quinine, Tincture Sesqui-Chloride of Iron, and Chlorate of Potassa: thus, ℞. Sulphate of Quinia, two drachms; Chlorate of Potassa, three drachms; Tincture of Sesqui-Chloride of Iron, one fluidounce; Hydrochloric Acid, one fluiddrachm; Distilled water, six fluidounces; mingle the Hydrochloric Acid and water, and dissolve the Quinine in this acid solution, and add the Tincture Muriate of Iron, and Chlorate of Potassa; dose teaspoonful, (60 drops,) in wine glassfull of water, sucked through a quill, one hour before each meal.

The following cases will illustrate the general characters and progress of the anasarca which complicated these cases of malarial disease.

CASE 635.—*Anasarca following protracted Intermittent fever; relieved by the use of Iron, Quinine,* *and diuretics.* Gustave Brok, native of Finland, age 57; sea-faring man, has always enjoyed good health up to the time of his residence in Louisiana, six months ago. Commenced work on the Railroad at Bloomfield, in a sickly malarious locality, and was seized with chills in the latter part of July, 1870; and suffered with a paroxysm (chill and fever) every other day, until he entered the Charity Hospital, (ward 25, bed 368,) November 24th, 1870. Swelling commenced in lower limbs a short time before entering the Hospital, and increased rapidly until the abdomen became distended with fluid, and the features of the face were bloated. The complexion was sallow and jaundiced. It was observed that the swelling was always greatest in the right leg. Liver somewhat enlarged, and sluggish in its action. Spleen greatly enlarged and indurated

Under the use of mercurials, (Blue Mass,) and Quinine, followed by Tartrate of Potassa, and Iron, and the mixture of Quinine, Chlorate of Potassa, Hydrochloric Acid and Tincture Muriate of Iron, this case progressed slowly but favorably; and on the 23d of February, 1871, every vestige of the ascites, anasarca and œdema had disappeared, and the complexion had assumed a clear and healthy appearance. Throughout the attack the urine was free from albumen, although at times, and especially during the paroxysms of the chill and fever, which recurred several times, containing biliary matters and presenting the usual changes characteristic of malarial fever.

We observed that the absence of albumen from those cases of dropsy which were clearly referable to the action of malaria, was a most favorable symptom.

During the months of November, December 1870, and January, February and March 1871, I treated in wards 24 and 25, Charity Hospital, 180 cases of disease, and of this number, more than one-half, or 114, were suffering with the various forms of malarial fever, (Pernicious, Remittent, Intermittent, and Chronic Malarial poisoning.) Of these one hundred and fourteen cases of malarial fever, one tenth were suffering with anasarca. Treated upon the principles just indicated, the entire number, including the fourteen cases complicated with anasarca, ascites and œdema, were relieved and were discharged cured—no death occurred. We attributed this favorable result to the persistent use of purgatives, diuretics, Iron and Quinine; as well as to the fact that in this series of cases, the liver, and kidneys were not seriously involved. We have from time to time, in both civil and military practice observed a number of cases of anasarca acccompanying the prolonged action of the malarial poison, and apparently dependent upon the alterations which it induced in the liver and spleen, which were only temporarily relieved by treatment, and which finally terminated fatally.

In such cases the liver as well as the spleen presented an altered and indurated appearance; and in a certain proportion also, the kidneys were involved.

CASE 636: *Chronic Malarial Poisoning, with Ascites and General Anasarca.*—Victor Sievaux, age 52, native of France; admitted ward 13th, bed 189, Charity Hospital, December 11th, 1872. Patient gives the following history: about nine months ago, May 1872, in Illinois, was attacked with Intermittent fever (chills and fever,) which continued about six months. Three months (October 15th,) before entering the Charity Hospital, he left Illinois and came down the Mississippi River to New Orleans, and while on the boat, was again attacked by chills and fever, and he observed that the chills were accompanied and followed by swelling of the abdomen and lower extremities. Was also greatly exposed on the deck of the steamer to cold which seemed to induce the first chill.

On the third day of the voyage down the Mississippi, the patient noticed that his feet and legs began to swell; the swelling gradually progressed upwards, until the abdomen became involved. After his arrival in New Orleans, on the 30th of October, there was no regularity in the attacks of fever, which assumed in turn, the quotidian, tertian and quartan types. Entered the Charity Hospital, and was so much relieved by the treatment with Quinine, Iron, and Bitartrate of Potassa, that at the end of three weeks, he left and endeavored to follow his occupation (Veterinary Surgery.)

At the end of twelve or fifteen days, the chills and fever returned, and the swelling of the abdomen and lower extremities appeared again, and increased rapidly.

Entered Ward 13th, December 11th, 1872; pale, sallow, anæmic; face presents a swollen bloated appearance; abdomen greatly distended with fluid; veins upon the walls of the abdomen, present a full distended and arborescent appearance; lower extremities swollen and distended to such an extent, that the patient walks with great difficulty, and in fact is compelled to lie in bed. Pulse accelerated and feeble. No appetite. Great depression and prostration. At times the patient cries, and says that there is no hope for his recovery.

Ten grains of Sulphate of Quinia, and twenty minims of Tincture of Opium, (Laudanum,) were administered this day, and repeated again on the 12th. On the next day, December 13th, I administered 5 grains of Sulphate of Quinia, every two hours, until the patient had taken 20 grains. These measures arrested the chills for a short period. As the dropsical effusion was increasing, I determined to employ a combination of diuretics and purgatives. A powder composed of forty grains of flowers of Sulphur, one ounce of Bitartrate of Potassa, and twenty grains of pulverized Jallap, was mixed with half a pint of water, and administered morning and evening. These powders produced free action on the bowels and kidneys, and were repeated daily. *Throughout this case the urine was free from albumen.*

December 18th. Patient has complained of a troublesome cough for several days, and to relieve this I ordered a mixture, composed of three drachms of Chloride of Ammonium, three fluidounces of Syrup of Squill, and two fluidounces of Syrup of Wild Cherry Bark, (Prunus Virginiana;) teaspoonful whenever the cough was troublesome. The Chloride of Ammonium was given for its alterative effects, which experience has shown, are often of value in the peculiar state of the blood, liver and spleen, characteristic of the prolonged action of the malarial poison. The squill was given for its expectorant and diuretic effects; and the Wild Cherry for its sedative and tonic effects.

December 19th. Ascites greatly diminished; lower extremities not so tense; patient says that he is much better. ℞. Quiniæ et Ferri Citratis, four drachms; Acidi Citrici, one drachm; Aquæ, Menth, Pip, six fluidounces; mix, teaspoonful three times a day.

December 20th, M., temperature axilla 100° F.; E. 100°.; 21st M., 99°.7, pulse 88; 22d M., 100.7. Patient had a chill at 11 A. M., December 22d; during the chill the temperature of the axilla was 101°.25 F.; whilst that of the hand was only 91°.5 F. I have observed that in many cases in which the action of the malarial poison has been prolonged, the rise of temperature in the trunk is not so marked as in cases in which the paroxysmal disease has been recently developed.

℞. Quiniæ Sulph, one and a half drachms; Ferri Sesqui Chloridi, one fluidounce; Aquæ Distillatæ, eleven fluidounces; mix; tablespoonful in wineglassful of water every four hours; suck through glass tube.

December 23d M., temperature 100°.5; 24th M., 100°.5. December 25th, had a chill at 8 A. M., which was followed by high fever. Ordered a powder composed of three grains of Sulphate of Quinia, one grain of Powdered Camphor, and one grain of Capsicum, to be given every three hours, and continued until ten powders have been taken. December 26th M., 98°; 27th M., 97°; 28th, 98°. December 28th, had a chill at 8 A. M., followed by fever. Repeated the Quinine, Camphor and Capsicum powders. Daily observations upon the temperature showed that it ranged from the 28th of December to the 20th of January, 1873, from 98° F. to 99°·5 F. During this period the patient was kept upon the Citrate of Iron and Quinine; the bowels were occasionally moved by Blue Mass combined with Quinine, and also by Magnesia and Bitartrate of Potassa. The improvement of the patient was marked, up to the 20th of January, when the temperature rose to 101° F., and reached 103°.4 F. on the 21st. This was the last paroxysm of fever. Quinine was freely given at this time, and the solution of Citrate of Iron and Quinine continued. The patient made a complete recovery, and was discharged on the 3d of February, in apparent health; all marks of the ascites and anasarca had disappeared, and the complexion presented the clear, rosy tint of health. This patient has visited me at various intervals, up to the present time July 1875, and presents the appearance of health, and says that he has had no return of the chills and fever or dropsy.

CASE 637: *Intermittent Fever; General Anasarca, Resulting from the Prolonged Action of Malaria.*—Patrick Flavin, age 46, native of Ireland. Entered ward 13, Charity Hospital, February 12th, 1873. Has been working in swamps and been exposed to cold and wet. Sallow, jaundiced, anæmical hue; excitable, feeble pulse; ordinary temperature but slightly elevated above the normal standard, but subject to oscillations much greater than those ordinarily observed in health. Had chills at various times, and on the 13th of February, the day after his entrance, the temperature rose after the chill to 103°.8 F.

On the 14th, 16th, 17th, 18th and 19th, the temperature oscillated between 99° and 100°.8 F.; and on the 20th, rose after a chill to 102° F.

I attributed the ascites and anasarca in this case, (*especially as in the preceding case, the heart's action was normal, and the urine entirely free from albumem,*) to the effects of the malarial poison in impoverishing the blood, and inducing obstructions in the portal and splenic circulations.

This patient was treated with entire success, upon the same general plan as that pursued in the preceding case, (Victor Sievaux.)

CASE 638: *Intermittent Fever; Chronic Malarial Poisoning; enlargement of Liver and Spleen; Anæmia; Anasarca.*—Noah Wilkinson, age 13, native of Georgia; laborer. Entered ward 13, bed 189, Charity Hospital, December 31st, 1874. Had suffered with chills and fever, for more than 12 months. Whilst passing through New Orleans with his father and mother, on the way to Texas, suffered with a paroxysm of fever, and was brought to the Hospital. His father and mother were in like manner brought to the hospital sick, and both died; they were not however under my care. Noah is pale, sallow and dropsical. Features of face, present a bloated, sallow, anæmic appearance, but little difference in color being observed between his pale lips, gums and tongue, and his face and hands. Hands swollen, bloodless and semi-transparent. Belly distended with dropsical effusion. Lower extremities and scrotum œdematous. Says that he lived in a low, damp, malarious locality in Georgia, and suffered with *chills and fever* for more than twelve months.

Quinine with several of the standard preparations of Iron, as the Citrate of Iron and

Quinine, Precipated Iron, Tincture Sesqui Chloride of Iron, were administered persistently at regular intervals; the bowels were occasionally moved by a mercurial, (either Blue Mass or Calomel,) and the action of the kidneys was promoted by the daily use of the Bitartrate of Potassa. A combination of Tincture of Quassia, Tincture of Rhubarb, and of Gentian and Cinchona, was also employed as a tonic and antiperiodic.

The patient improved slowly but steadily during the month of January, 1875, the pulse ranging from 60 to 70, and the temperature varying from 99 to 99.5 in the axilla, the anasarca disappearing, the complexion assuming a clearer and more ruddy hue, and the general health and spirits improving.

On the 10th of February he was seized with violent convulsions, attended with rapid tumultuous action of the heart, elevation of temperature and coma. The convulsions commenced at 3 A. M., February 10th, and continued at intervals of 15 minutes, for 30 hours. During the convulsions every muscle of the body was thrown into violent action, consisting of numerous short jerks; the head was moved rapidly from side to side; the face became of a deep purple; the veins of the neck were greatly distended, and the action of the heart was tumultuous and powerful; one pupil was dilated and the other contracted.

At 8 A. M., the pulse was 136, temperature of axilla 103.5 F.; 5 P. M., pulse 140, respiration 56, temperature of axilla 106°.75. I applied a blister 2 by 4 inches to the back of the neck, ice bags to the head, sinapisms to the extremities; opened the bowels with purgative enema, and administered internally, freely Calomel and Quinine. Oil of Turpentine was also applied locally over the region of the lungs, as the patient appeared to suffer from oppression in breathing, and percussion revealed dullness. After the evacuation of the bowels, Quinine was administered by enema together with diluted brandy; and large doses of the Bromide of Potassium were administered internally at regular intervals during the night.

The blister drew well; the bowels were freely evacuated, and the following morning, Feb'y 11th, the patient appeared to be more quiet, the convulsions were not so violent and recurred at much longer intervals: 8 A. M., pulse 144, respiration 48, temperature of axilla 104° F.; 8 P. M., pulse 130, respiration 36, temperature 104°.5 F. The patient has continued to improve during this day, and has taken Quinine, Beef tea and milk punch by the mouth.

February 12th, rational; no spasms; complains of severe pain in the muscles of the body, and especially in those of the arms and chest. Eight A. M., pulse 116, respiration 36, temperature 101° F.; 8 P. M., pulse 120, respiration 36, temperature 105°.75. During the night a marked remission of the fever took place, and the next morning, February 13, the pulse was 98, respiration 28, and temperature of axilla 101° F. The fever returned, however, again on the 14th, but without the convulsions; 8 A. M., pulse 128, respiration 44, temperature of axilla 104°; 8 P. M., temperature 103°. The patient suffered with a cough dependent upon bronchial irritation, also with fever, the tongue being heavily coated with brown fur and red at the tips and edges. He sat up for the first time, on the 17th.

The pulse continued up to the 2d of March, to range from 90 to 120. Marked rises of temperature were noticed on the 18th and 26th of February; the following observations were made upon the variations of temperature. February 15th, M. 100.5°, E. 102°; 16th, M. 101°, E. 102°; 17th, M. 101°, E. 102°; 18th, M. 101°.5, E. 102°.25; 19th, M. 101°.5, E. 101°.5; 20th, M. 103°.5, E. 101°.25; 21st, M. 101°.5, E. 102°; 22d, M. 101°.5, E. 99°; 23rd M. 101°.5, E. 101°.5; 24th, M. 101°.5, E. 101°; 25th, M. 101°, E. 101°; 26th, M. 104°, E. 104°.25; 27th, M. 101°, E. 101°; 28th, M. 101° F., E. 101°; March 1st, M. 102°, E. 101°. The paroxysmal character of the disease was clearly shown by the variations of temperature, and the spasms appeared to have been directly caused by the action of malaria, for they were relieved under the combined action of quinine, counter-irritants, purgatives and stimulants.

Under the persistent use of Quinine, Iron, Tincture of Bark, and small doses of Arsenious Acid, this patient slowly improved, and was discharged on the 1st of April, 1875.

The urine was free from albumen, thoughout the preceding cases.

CASE 639: *Intermittent Fever, Chronic Malarial Poisoning; Anæmia; Œdema of Lower Extremities.* T. Mc., age 25, native of Ireland, laborer, entered ward 30, Charity Hospital, November 28th, 1874. Has been working in the swamps and has had Malarial Fever for three months, with little or no treatment. Liver and spleen enlarged; anæmia; marked œdema of lower extremities; scrotum swollen and pits upon pressure. No albumen in urine. Under the persistent use of Quinine, Iron, Quassia and Bitartrate of Potassa, recovered, and was discharged Dec. 31st, 1874.

CASE 640: *Intermittent Fever; Chronic Malarial Poisoning; Anæmia; Œdema of Lower Extremities and Scrotum.*—J. O. D., age 24, native of Ireland, laborer, contracted Malarial Fever in swamps; entered ward 29, Charity Hospital, November 29th. Liver and spleen enlarged; pale, sallow complexion; anæmic; has suffered with chills and fever for two months; lower extremities and scrotum greatly swollen. Albumen present in small amount in urine. Improved rapidly, on the treatment with Quinia, Iron, Bitter Tonics and Tartrate of Potassa; discharged December 15th.

CASE 641: *Intermittent Fever; Chronic Malarial Poisoning; Enlarged Spleen; Anæmia; Ana-*

sarca.—G. M., age 23, native of Germany; entered ward 29, Charity Hospital, November 30th, 1874. Has been working in swamps and marshes, and has suffered with chills and fever for two months. Spleen greatly enlarged; pale, sallow complexion; anæmic; lower extremities and scrotum œdematous. Improved under a treatment similar to that instituted in the preceding case; discharged December 21st.

Case 642: *Intermittent Fever; Chronic Malarial Poisoning; Enlarged Spleen; Anæmia; Œdema of Scrotum and Lower Extremities.*—J. S., age 31, native of Ireland, laborer; entered ward 13, Charity Hospital, Dec. 3d, 1874. Has suffered with Intermittent Fever for six weeks; spleen enlarged; anæmia; œdema of scrotum and lower extremities; urine slightly albuminous. Under the treatment specified in the preceding cases, restored to health and discharged Dec. 22d.

Case 643: *Intermittent Fever; Chronic Malarial Poisoning; Enlarged Spleen; Anæmia; Anasarca.*—Daniel Gary, age 31, native of Kentucky, laborer. Has suffered with chill and fever for three months, whilst working in malarious swampy region, and during this time has had little or no treatment. Entered ward 29, Charity Hospital, Dec. 10th, 1874; sallow, pale, slightly jaundiced complexion. Anæmia; spleen enlarged; lower extremities and scrotum œdematous; belly distended; countenance presents a swollen, bloated appearance; anasarca; no albumen in urine. Improved under treatment, and was discharged January 31st, 1875.

Case 644: *Intermittent Fever; Chronic Malarial Poisoning; Anæmia; Anasarca.*—J. McGinty, age 30, native of Ireland, laborer; entered ward 30, Charity Hospital, Dec. 28th, 1874; spleen enlarged; anæmia; anasarca; no albumen in urine. Improved under treatment with Quinia, Iron and Bitartrate of Potassa, and Tinc. Quassia and Cinchona. Discharged February 7th, 1875.

Cases 645–655.—Similar to preceding, and relieved by similar measures.

Case 656: *Persistent Intermittent Fever: Anæmia and Anasarca.*—John Hirscher, age 32; native of Germany; contracted malarial fever in the swamps of Louisiana. Entered Ward 30, C. H., October 8th, 1874, with fever and anasarca.

No albumen in urine. Heart and lungs normal. Treated with Quinine, Iron and Bitartrate of Potassa. Recovered.

Case 657: *Intermittent Fever, and Chronic Malarial Poisoning.*—Frank Leonard; native of Pennsylvania; laborer; has suffered with intermittent fever for about one month. Entered Ward 30, C. H., Nov. 10th. Lower extremities, scrotum, and penis distended with dropsical effusion. Pale, sallow-anæmic; great deficiency of red corpuscles. *No albumen in urine.* Heart normal.

Recovered under the usual treatment with Quinine, Iron and Bitartrate of Potassa. Discharged November 25th.

Case 658: *Intermittent Fever; Chronic Malarial Poisoning; Anasarca.*—Circumscribed deposits of yellow pigment in skin. Anæmia.

Thomas McElroy, age 30; native of Ireland. Brown hair, brown eyes, Entered Ward 30, B. 446, C. H., Nov. 15th, 1874. Has had chills and fever, with little or no treatment, for nine weeks. Features swollen; pale, sallow and swollen, with several brownish yellow spots These spots, which vary in size, from half an inch to three inches in diameter, are found upon various portions of the body. Some effusion in abdominal cavity. Lower extremities œdematous. *Heart normal.* No albumen in urine. Recovery under Iron, Quinia and Bitartrate of Potassa, and nutritious diet, slow, but complete. Discharged Dec. 24th.

Case 659: *Intermittent Fever of Two Months; Anæmia; Anasarca; Enlarged Spleen.*—James Brown, age 25; laborer; native of Ireland. Contracted malarial fever whilst working in swamps and low grounds on Mississippi River, in the month of August. Entered W. 29, B. 422, C. H., Nov. 17th, 1874. Pale anæmic, with loss of muscular and nervous power. Great œdema of lower extremities. *No albumen in urine.* Heart normal. Under the usual treatment with Quinine, Iron and Bitartrate of Potassa, recovered, and was discharged Dec. 9th.

Case 660: *Intermittent Fever; Anæmia; Œdema of Lower Extremities; Enlarged Spleen.*—Thomas Reid, age 30; native of Ireland; laborer. Entered Ward 30, C. H., Nov. 17th, 1874. Has suffered with intermittent fever for "several weeks," during which time has had little or no treatment. Pale, sallow complexion; anæmic; lower extremities much swollen. No albumen in urine. The usual treatment with Quinine, Iron and Bitatrate of Potassa, resulted in the removal of the effused liquid, and the improvement of the blood, and the establishment of health, and the patient was discharged Dec. 3d, 1874.

Case 661: *Intermittent Fever; Chronic Malarial Poisoning; Enlargement of Liver and Spleen; Anæmia; Diarrhœa; Œdema of Lower Extremities.*—J. M. Budge, age 39; native of Florida; pedler. Has suffered with malarial fever 5 months. Entered Ward 30, C. H., Nov. 17th, 1874. Pale, sallow hue; anæmic; liver and spleen both enlarged; lower extremities greatly swollen; pitting deeply upon pressure. No albumen in urine. The persistent use of Quinine, Iron and Bitartrate of Potassa removed the malarial disease, restored the constitution of the blood, and relieved the dropsical effusion; patient discharged, Dec. 30th, 1874.

Case 662: *Intermittent Fever; Chronic Malaial Poisoning; Enlarged Liver and Spleen; Anæmia;*

Anasarca.—H. S., age 56; native of Connecticut; sailor. Entered Ward 29, C. H., Nov. 23. Has suffered with malarial fever for three months. Pale, sallow complexion; anæmic; liver and spleen both enlarged. General anasarca. No albumen in urine. Patient died on the 24th, the day after his entrance into the hospital. Death appeared to be directly caused by the profound lesions of the blood, liver and spleen, due to the prolonged action of the malarial poison.

CASE 663: *Malarial Fever; Anæmia; Anasarca; Coma.*——————, Entered Ward 13, C. H., Nov. 17th, 1874. Patient entered in an insensible condition. Temperature of axilla, 104° F. Nov. 18th, morning, temperature of axilla, 103° F.; evening, 104°.5 F. Nov. 19th, morning, temperature of axilla, 106° F.; died shortly after this observation. Quinine in large doses was administered by enema, and sinapisms applied to the extremities, but without any beneficial results.

CASE 664: *Persistent Intermittent Fever; Chronic Malarial Poisoning; Anæmia; General Anasarca; Coma; Death with High Temperature; Pigment deposited in Brain, Liver and Spleen.*—Emanuel Carnerio; native of Portugal, age 13. Entered Charity Hospital, Ward 30, bed 449, Oct. 3d, 1874. Has had intermittent fever for four months, and has had no medical treatment. Pale, anæmic, sallow, yellowish green complexion; abdomen, scrotum and lower extremities distended with serous effusion. Scrotum about three inches in diameter, semi-transparent; pits upon pressure; serous fluid confined chiefly to the cellular tissue. Urine entirely free from albumen. Appeared to improve upon Quinine, Iron and nutritious diet. The dropsical effusion was reduced to a marked extent by the Bitartrate of Potassa. Heart and lungs normal. On the 3d of November the patient suddenly became comatose. The coma was attended with violent and rapid cardiac action, and a marked rise of temperature. On the morning of the second day, one and a half hours before death, the thermometer in the axilla indicated 107°.5 F. Quinine and counter-irritants had no effect, and the patient died comatose, November 5th, 1874.

Post-mortem Examination, six hours after death.—Brain congested; gray matter dark bluish color; structures of the cerebrum and cerebellum loaded with dark pigment granules, deposited chiefly in the walls of the smaller blood-vessels and capillaries. Under the microscope, the course of the smaller blood-vessels in the cerebral substance could be readily traced everywhere, by the vast number of pigment granules. Liver, slate on the exterior, and bronzed within, and loaded with black pigment particles, which were deposited in greatest numbers in the portal capillaries in the periphery of the lobuli. Spleen enlarged and loaded with black pigment. Heart normal; muscular structures, under the microscope, normal. Blood very watery, and deficient in colored corpuscles.

CASE 665: *Chronic Malarial Poisoning; Ascites; Anasarca of Lower Extremities; Obstinate Diarrhœa; Anæmia; Sudden accumulation of Fluid in Right Pleura; Side punctured, and relieved of 1½ gallons of Serous Fluid; Sudden Death; Pigment in Liver and Spleen.*—Thomas Eagan, age 47; native of Ireland; laborer. Entered Charity Hospital, Ward 13, bed 183, Nov. 17th, 1874. Height six feet; brown hair, brown eyes. Has suffered during the summer and autumn with malarial fever, contracted in the swamps of the Mississippi river. Pale, anæmic; lips and tongue have but little more color than his sallow face. Abdominal cavity distended with dropsical effusion; lower extremities also greatly swollen, presenting a semi-transparent appearance, and pitting upon pressure. Has suffered during the past five weeks with constant diarrhœa. *Diagnosis:* Chronic malarial poisoning; portal and splenic obstructions; anæmia; ascites; anasarca; chronic diarrhœa. Prognosis unfavorable.

Quinine, Iron and generous diet induced some improvement, and the dropsical effusion was controlled to a certain extent by the Bitartrate of Potassa, employed in purgative and diuretic doses. But the diarrhœa was troublesome, and with difficulty controlled. When, by the use of Sub-Nitrate of Bismuth, Opium, Ipecac and Astringents, the diarrhœa was checked, the dropsical effusion rapidly accumulated. When the diarrhœa was uncontrolled, the effused liquid diminished, but the strength of the patient was sensibly and steadily reduced. The respiration varied from 20 to 24 per minute, and the temperature either remained at the normal standard, or was occasionally, in the evening, slightly elevated, ranging from 99° F. to 101° F. Repeated examinations of the urine revealed the absence of albumen.

Whilst endeavoring to enrich the blood, which was, to a marked extent, deficient in red corpuscles, and at the same time to control the diarrhœa and promote the free action of the kidneys, the patient appeared not merely to hold his ground, but even to improve slowly; when, after a cold spell of weather in the early part of January, on the 11th, the patient complained of severe pain in the right side. Up to this time nothing abnormal whatever had been noticed, either in the lungs or heart.

Auscultation and percussion revealed the presence of a large amount of serous fluid in the right pleuritic cavity. The liquid was suddenly effused, and accumulated with such rapidity as to produce a marked increase of the right side, anteriorly, posteriorly and laterally; and at the same time the lung was pressed upwards and interiorly towards its attachment to the right bronchus. Great dyspnœa supervened; the patient was compelled to sit up night and day. The lips and hands presented a purple appearance, and the respiratory sounds were heard only in a circumscribed space, between the second and fourth ribs on the right side; whilst the left lung was normal in its actions, with increased resonance. A blister 6 by 8 inches, over the seat of the pain on the right chest, produced some temporary relief; Squills Digitalis and Quinine, with purgatives, in like manner produced only temporary relief. On the 16th of January, the right pleural cavity was evacuated, by means of the aspirator, and 1½ gallons of clear, serous liquid was drawn off, with great temporary relief to the patient. The serous liquid rapidly accumulated in the right pleural cavity, with a return of the distressing symptoms, and when it was deemed necessary to repeat the operation for the evacuation of the pleuritic effusion, the patient died suddenly in bed, on the 31st of January, 1875.

Post Mortem Examination—Six hours after death. *Exterior.*—Abdomen distended, lower extremities greatly swollen; right side of chest very prominent and flat upon percussion.

Thorax.—Left pleura and lung healthy. Heart normal; right pleura distended with about one and a half gallons of clear, light yellow, serous fluid, entirely free from pus. Delicate membranes were observed attaching the surfaces of the walls of the thorax and lung, especially around the seat of the puncture. These membranes were of great delicacy and beauty. Their cohesive power was so slight as to be readily ruptured upon the slightest touch. Right lung contracted and compressed into a small mass, which presented a carnified appearance when cut open.

Abdominal Cavity contained more than one gallon of serous liquid similar to that found in the right pleura. Lymphatic glands of mesentery enlarged and hardened. Mucous membrane of ilium and colon greatly congested and "*inflamed.*" Gall bladder filled with gall stones. Liver enlarged, slate colored on the exterior, bronzed within; and under the microscope, loaded with black pigment matter deposited chiefly in the Portal Capillary network upon the periphery of the lobuli. Liver cells pale, with comparatively few oil globules; many of the liver cells contained dark-pigment granules. Spleen enlarged and loaded with black pigment particles.

Careful microscopical examination revealed no structural alterations in the muscles of the Heart. Malarial fever produces no alterations in the muscular structures of the heart. Yellow fever on the other hand produces profound alterations as I have before shown.

The following cases recorded by Frerichs, in his work on Diseases of the Liver, are important in the light which they throw upon this comparatively obscure and imperfectly understood complication of Malarial fever.

CASE 666: *Tertian and Quotidian Intermittent of three months' duration; Anasarca; Ascites; Diarrhœa; Death from Exhaustion; Atrophied Pigment Liver; and Pigment Spleen.*—A boy 10 years of age, who had been much neglected, and who, for three months, had suffered almost uninterruptedly from Intermittent fever, at first of a Tertian, and afterwards of a Quotidian type, came to the hospital at the beginning of May, 1855, with a pale, anæmic countenance, and suffering from profuse watery diarrhœa. The spleen was moderately enlarged. No hepatic dullness could be detected in front; in the axillary line it amounted to 2 centimètres (⅘ inch). The lower part of the abdomen contained a considerable quantity of fluid, but there was scarcely any obvious œdema of the feet. The evacuations by stool, which occurred six or eight times in the course of the day, were then of a grayish-yellow, and without any traces either of blood or dysentery exudations. Pulse 90, and small; no elevation of temperature. Appetite slight. The urine, when treated with heat and nitric acid, exhibited scarcely any turbidity.

The attempts to check the exhausting evacuations by means of Chloride of Iron, Nux Vomica, etc., and to counteract the anæmia by means of a regulated diet, proved fruitless. After three days' stay in the Hospital, the boy died.

Autopsy.—Considerable Ascites; slight Anasarca. No important changes in the organs of the cranial or thoracic cavities. The mucous membrane of the stomach and intestinal canal pale, at some places œdematous; the serous membrane of the small and large intestine exhibited here and there livid spots,—the remains of ecchymoses. The kidneys were normal, with the exception of a few isolated pigment-granules in the glomeruli.

The spleen was large, firm, congested, and densely infiltrated with black pigment.

The liver was very small and atrophied; numerous deep depressions were seen upon its outer surface. Its parenchyma was congested, brownish-black, and of tenacious consistence. Yellow size injected into the portal vein passed along very incompletely: in thin sections of the injected tissue, the ramifications of the portal vein, as far as their entrance into the lobules, could be seen to be much enlarged, and at some places, unequally so. Black pigment was observed in the interior of the capillaries, only a few of which were injected; a large number of them appeared to be no longer permeable. (Diseases of the Liver, New Syd. Soc., 1860, vol. i, p. 258).

CASE 667: *Persistent and oft-recurring Quotidian Intermittent; Hydræmia; Anasarca; Ascites;*

Profuse Diarrhœa; Death from Exhaustion. Atrophy of the Liver: Blocking up of the Capillaries with Pigment.—Mrs. M., aged 26, before she came to the Hospital, on April 27th, 1855, had suffered for several months during the winter from intermittent fever. This fever continued for a long time after the patient's admission, and did not permanently disappear until after the repeated administration of large doses of Quinine. The patient became gradually reduced to an extreme degree of anæmia, to which general anasarca and ascites were superadded, and which rapidly increased to a critical degree, under the additional operation of persistent and profuse diarrhœa, (to check which, the vegetable and metallic astringents, particularly the Muriate of Iron, were employed without effect). Death took place six weeks after admission. Neither albuminuria, nor derangements of the sensorial functions, which before admission had accompanied intermittent fever, were observed at any time during the patient's stay at the Hospital.

Autopsy.—There was nothing abnormal in the brain; the lungs were anæmic and collapsed; and there was a moderate amount of effusion in the pleural cavities. The heart was normal. The abdominal cavity contained several pounds of clear, serous fluid.

The liver was small;* it weighed 1.7 kilogr, (1 lb. 8⅔ oz. av). and was thus less than one-half the normal weight; at the same time it appeared shriveled and tenacious, (welk u. zahe), and its parenchyma was congested and dark. Under the microscope, numerous flakes of pigment could be seen in the capillary vessels, some of which were remarkably large. The ramifications of the portal vein were greatly enlarged as far as the periphery of the lobules, but attempts to inject them proved very unsuccessful. A large proportion of the capillaries contained pigment, and were from this cause, impermeable by the injection. The surrounding hepatic cells were either atrophied or filled with fat; at some places, lardaceous matter (*Speckstoffe*) was observed. Sugar could not be detected in the liver.

The spleen was small†, firm, and colored brownish-black, owing to dense accumulations of pigment; its capsule was thickened. The kidneys were normal, except that isolated pigment granules were seen in the glomeruli. The mucous membrane of the intestine was pale and œdematous; in the sigmoid flexure there were a couple of superficial catarrhal ulcerations.

The origin of the atrophy in this case could not be traced with certainty. The pigment flakes and granules, which not unfrequently are found in the spleen in the course of severe intermittents, and from this organ are transmitted into the portal vein partly, and pass in through the capillary network of this vessel, and partly owing to their size, remain firmly impacted in it, and give rise to occlusion ending gradually in obliteration. The obstructed flow of blood entails an arrest of the secretion, and destruction of the glandular cells. Occasionally it happens that large clots are swept along into the vessels of the liver; scar-like depressions are then produced at these parts of the surface of this organ to which the obstructed vessels lead. (See Diseases of the Portal Vein.): pp. 259–261.

Case 668: *Persistent Intermittent Fever; Anæmia and Hydræmia; Exhausting Diarrhœa, with but little Bile in the Stools; Death under Cerebral symptoms; Fatty Degeneration of the Liver; Small Lardaceous Spleen; A limited Cancerous Ulcer in the Cæcum.*—I. Palliska, aged 31, during July and August 1853, was treated in the Clinique for Anæmia, without benefit. He was a large, broad-shouldered man, of a pale, waxy countenance, and complained of remarkable weakness, accompanied by wandering pains and deranged digestion.

At the origin of the aorta, there was heard a systolic bruit, which was propagated into the carotids; lungs healthy; spleen and liver of normal size; the tongue slightly coated; the bowels were moved two or three times in the day, and the stools were of a pale color; urine had a specific gravity of 1012, and was free from albumen. Under the use of the preparations of steel, the etherial tincture of the muriate of iron, the lactate of iron, etc., the appetite increased; but the paleness, the feeling of weakness, and the other symptoms of anæmia, remained unchanged, notwithstanding a full diet. The patient left the hospital, and did not return until the 16th of February, 1854. The anæmia had now increased to hydræmia; anasarca and ascites had supervened; there were from six to ten pale stools daily; a tender induration, which, however, was not very accurately circumscribed, could be felt upon palpation in the cæcal region; urine 1007, pale and without albumen; blood drawn off by a cupping glass showed no increase of the white corpuscles. Vegetable and mineral astringents, nux vomica, etc., were administered in vain to check the diarrhœa. On the evening of the 25th, loss of consciousness set in suddenly, the speech became stammering, the features distorted, and the eyes fixed and staring; pupils dilated; pulse slow and thready; the respiration slow and feeble. On the 26th he died.

Autopsy.—The contents of the cranial cavity presented nothing abnormal. The bronchi were empty, and the lungs were œdematous; the heart appeared unchanged in its muscular tissue and valvular apparatus. About four pounds of clear serum were found in the abdominal cavity. The mucous membrane of the stomach and of the small intestine, as far as the ilio-cæcal valve was pale. The cæcum over its greater extent was firmly adherent to the fossa iliaca, and its mucous membrane was partially converted into an ulcerated surface of a dirty-gray, ragged character; the walls of the cæcum presented a pulpy infiltration about five lines in thickness. The lower portion of the intestinal canal, as also the retro-peritoneal glands remained intact.

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*The right lobe was 5½ inches long, and 4 broad; the left, 4 by 3¼; the thickness amounted to 2 inches.

†It measured 3 inches in length, 2½ in breadth, and 1½ in thickness. Its weight amounted to 0.14 kilogrs (5 oz. avoird.)

The spleen was slightly enlarged five inches long, and three in breadth; its consistence was firm, and its cut surface glistening.

The liver was of normal size; its surface was smooth, and its margins sharp; the secreting cells had an irregular outline, and most of them contained no nucleus, but were filled with fine granules and drops of oil, and some of them also with brown pigment. The gall-bladder contained a small quantity of yellow mucus, and in the gall ducts within the liver, were aggregated masses of cylindrical epithelium of a gray color. The liver contained no sugar, but large quantities of leucine and tyrosine.

The patient attributed his illness to an obstinate intermittent fever, from which he had suffered during three months, 2¼ years before his death. The altered condition of the spleen and liver, which must be regarded as constituting the starting point of the anæmia, apparently dated from that period. The spleen which was scarcely enlarged, was in a state of lardaceous degeneration, and the liver was affected with fatty degeneration, such as we find as a final result of infiltration of the parenchyma with albuminous matter, in consequence of malarious poison, constitutional syphilis, etc., which may or may not be accompanied by lardaceous degeneration of the spleen, kidneys, and lymphatic gland. The functions of the liver under these circumstances were in a great measure destroyed, and the results, which the suspension of these functions entails upon the entire system, ensued.

The limited cancerous deposit in the cæcum, which did not make its appearance until the symptoms of anæmia had already existed for two years, might have contributed to expedite the death from exhaustion, but could not be regarded as the cause of the poverty of the blood, pp. 309, 311.

CASE 669: *Persistent and oft-recurring Intermittent Fever, ultimately of a quartan type; Albuminuria of a high grade; fibrinous casts, with pigment in urine.; Œdema; Rapidly supervening Ascites; Tapping after the inefficacious employment of steel and purgatives; Return of the Fever; Paroxysm of two day's duration; Death from exhaustion; Pigment in the Spleen; Occlusion of the Hepatic Capillaries; Atrophy of the Liver; Accumulation of Pigment in the Kidneys; Consecutive Pneumonia.* Doroth Scheimer, age 28, a laborer's wife, was in the clinical ward, from the 17th May to the 31st July. She had suffered repeatedly from intermittent fever of various types, and during last winter, from an almost uninterrupted quartan fever. At the time of her admission, the form of the fever was double quartan. For fourteen days the patient had observed œdema of the feet, and a remarkable diminution in the secretion of urine; the urine was turbid, greyish-yellow, and contained an enormous number of fibrinous casts, which were partly covered by black pigment granules and cells. By boiling, the urine was converted into a solid coagulum. The region of the kidneys was tender upon pressure. The spleen extended about 4 centimetres 1⅗ inchs beyond the margin of the false ribs. The blood drawn off by means of a cupping glass (care being taken to avoid the admixture of any foreign matter,) contained brownish and black pigment masses, in the form of scales (*Schollen*) and cells.

After taking a drachm of Quinine, the attacks of fever ceased. The characters of the urine, however, did not alter, and it continued scanty; there was repeated vomiting of a greenish mucous fluid, without any headache or darkening of the countenance. Was ordered lemon juice. The quantity of urine diminished somewhat, the vomiting ceased, and the appetite improved. Was ordered lactate of iron. The œdema of the feet diminished, but ascites became rapidly developed to such a degree as to interfere with respiration. Colocynth, gamboge and similar purgatives were of little avail against the dropsy; the energetic employment of these remedies only gave rise to derangements of digestion, vomiting, etc., so that it did not appear advisable to persist in them.

On the 10th of July, twelve pounds of clear serum were drawn off by the tapping. The volume of the liver, which could now be determined with greater accuracy, was slightly diminished.

On the afternoon of July 12th, there was an attack of fever,—rigors, heat, and sweating; the fever did not return on the 13th.

On the night of the 14th, after the usual interval, notwithstanding the employment of quinine, the paroxysm again made its appearance; the pulse continued very frequent, rose to 140, and was scarcely perceptible, without one being able to detect any cerebral disturbances, dyspnœa or physical changes in the heart or pericardium. The pulse continued frequent from the evening of the 14th to the morning of the 17th, when it suddenly sank to 88. No fresh attack of fever took place; the pulse remained to the last varying between 80 and 90, but the ascites rapidly increased, and the œdema of the feet spread to a remarkable extent. The patient became rapidly prostrated; and, after a protracted agony, death took place on the 31st, without any cerebral symptoms.

Autopsy, August 1st, 12 hours after death.—No remarkable alteration was observed in the skull-cap, meninges or substance of the brain, either in their amount of blood, color or consistence. The mucous membrane of the air-passages was pale; the left lung was œdematous superiorly; inferiorly, it was infiltrated, but only to a slight extent with soft exudation; the pleura, at this place was covered with a thin layer of gray, flaky exudation. The right lung was hypostatic posteriorly, and emphysematous along its anterior margin. The pericardium contained about three ounces of clear serum; the muscular tissue and valvular apparatus of the heart were normal. The blood in the right auricle was firmly coagulated.

The œsophagus was pale. The mucous membrane of the stomach was ecchymosed at some places, and, around the pylorus was of a slaty, gray hue. The lining-membrane of the bowel was pale superiorly, and in the large intestine was œdematous, and at some places the larger vessels were injected. The fæces were yellow. The pancreas and mesenteric glands were normal.

The spleen was enlarged, but flabby and shrivelled; its capsule was thickened, and its parenchyma was tenacious (Zahe), and of a bluish, gray color.

The left lobe of the liver had a broad atrophied rim; white traces of obliterated vessels could be seen in its serous covering. The parenchyma had a smooth surface on section, was somewhat friable, and of a grayish-brown color. The entire volume of the organ was diminished. The gall-bladder was found to be adherent to the stomach and colon, and was greatly distended with a green, mucous, somewhat albuminous, bile.

On microscopic examination, the usual forms of black pigment could be detected in the spleen, in the blood of the portal vein, and in the capillaries of the liver.

The kidneys were of normal size; their surface was smooth; their capsule firmly adherent; and their cortical substance grayish yellow, soft and friable. The microscope showed the existence of pigment in the glomeruli, as also in the vessels of the cortical substance, and occasionally, also in the interior of the uriniferous tubes.

The mucous membrane of the bladder was ecchymosed; the urine was scanty and albuminous.

The genital organs were not altered to any great extent; there was a cryst the size of a hazel-nut in the right ovary. pp. 348–350.

CASE 670: *Intermittent Fever, of a Tertian and Quotidian Type, lasting for Seven Weeks; Intestinal Catarrh; Hydræmia; Anasarca; Improvement under Preparations of Steel; Relapse; Rapid Increase of the Dropsy; Unconsciousness; Death; Pigment in the Spleen and Liver, without any Implication of the Brain or Kidneys.*—Franz Krocker, age 45; a worker on the roads. Came to the hospital on the 1st November, 1854. For seven weeks he had suffered from an intermittent fever, at one time of a tertian, and at another, of a quotidian type; and four weeks before, anasarca had made its appearance. The spleen was found to be considerably enlarged, extending about three inches beyond the margin of the false ribs; the heart and lungs were normal; there was no albumen in the urine; the bowels were relaxed, and the motions thin.

After the arrest of the fever, by means of Quinine, the patient's condition improved; under the use of nutritious diet, wine and the preparations of Iron, the aansarca receded, and the diarrhœa abated, until the 8th of November, when the temperature became elevated, the pulse rose from 96 to 100, and dyspnœa, with sibilus and rhoncus in the air-passages, and acute headache, made their appearance. At the same time, a copious effusion of fluid was detected in the abdominal cavity, and, soon afterwards in the pleural sacks likewise. Although this change in the patient's condition did not in any way resemble a fever paroxysm, yet, considering the uncertain character presented by the malignant forms of fever, recourse was had to Quinine. The patient, however, rapidly collapsed; his color became earthy; somnolence set in, and on the 14th, he died.

Autopsy, twenty-four hours after death.—The body was greatly swollen from dropsy. The meninges and substance of the brain contained the normal amount of blood. There was no alteration in the color or consistence of the brain, and no pigment in the capillaries of the cortical substance.

The mucous membrane of the air-passages was slightly reddened, and covered with gray mucous. Several pounds of serum were found in each pleural cavity. The lungs were anæmic, and of a dirty, gray color, with emphysematous margins superiorly; inferiorly, they were compressed and non-crepitant.

The pericardium contained a pound of clear serum; in the heart, there was loosely coagulated blood, in which pigment was found in tolerable quantity. The muscular tissue and valvular apparatus of the heart were normal.

The peritoneal sac contained many pounds of clear serum. The stomach and intestinal canal were.pale, but in other respects healthy. The spleen was very large, its capsule was tensely distended; its parenchyma was soft, and of a dark, grayish brown color.

The liver was shrivelled up at its margins; the serous membrane along the anterior rim of the left, as well as of the right lobe, was opaque, from recent exudation, and covered with pale red, newly formed vessels. The hepatic tissue was of a dark, grayish-brown color, and of soft consistence. Here, as well as in the spleen, there were large masses of pigment.

Bile, thin, pale and albuminous.

Kidneys anæmic.

Urinary bladder and prostate, normal. pp. 250–352.

(A Clinical Treatise on Diseases of the Liver, by Dr. Fried. Theod. Frerichs. Trans. by Charles Murchison, M. D., London, 1860, Vol. I.)

Several cases, similar in all respects to those just recorded, have come under our observation, following protracted intermittents, and consequent upon the prolonged action of the malarial poison.

These cases were characterized by a pale, sallow, anæmic, unhealthy, jaundiced hue. The lips and mucous membrane of the mouth and tongue was bloodless. Microscopical and chemical examination showed the absence, or rather great diminution of the colored blood corpuscles, without any abnormal increase of the colorless corpuscles, and thus we were enabled to distinguish the cases from Leukocythæmia. Irregular and deranged action of the liver was inferred from the jaundiced complexion, which presented more of a greenish hue than in acute jaundice. The muscular and nervous forces were greatly depressed, and the general condition that of mental and physical weakness, with aversion to all exertion, and absolute depression, and abject apathy. In most cases, the patients were afflicted with a continuous and uncontrollable diarrhœa, which could not be reached by remedies. Notwithstanding the continuous diarrhœa, the extremities became œdematous, and serous fluid was thrown out into the abdominal cavity. Even in the most extreme depression and exhaustion, the features and limbs presented a swollen, puffed and bloated appearance.

The post-mortem examinations revealed, as in the preceding cases, enlargement and induration of the spleen, with induration, and pigmentary infiltration of the liver.

By numerous post-mortem examinations, we have established the fact, that in acute cases of malarial fever, (Congestive, Remittent and Intermittent), an immense number of colored blood corpuscles are destroyed in the spleen, and perhaps also in the liver. In such cases, the enlarged spleen resembles a soft bag of diffluent, purplish, red and black mud. Under the microscope, this mud is found to consist of colored blood corpuscles in various stages of decomposition.

If the views of Frerichs, with reference to the subsequent pathological effects of the decomposing blood corpuscles, and resulting pigmentary matter, be correct, we must look to the changes of the blood in the spleen as the primary cause of this form of malarial dropsy.

Frerichs assumes that the capillaries of the splenic artery pour their blood into a system of large sinuses, whence it passes into the efferent veins; even in the normal state, the blood which has flowed rapidly through the narrow capillaries, would pass more slowly through the ample channel of the venous sinuses, and not unfrequently would stagnate in some places so that conglomerate masses of blood corpuscles would be formed, which gradually might be transformed into pigment. In the intense congestion, which experience shows attack the spleen, as a consequence of intermittent fever, these stagnations are very great, and would lead to considerable accumulation of pigment. According to this view, the pigment would arise from the stagnation of the blood in the venous sinuses of the spleen; the club and spindle shaped pigment cells are the epithelium of the lining membrane of the sinuses infiltrated with the decomposed red matter of the blood, the globular pigment cells are colorless blood corpuscles, infiltrated with molecules of coloring matter, and the pigment scales are the broken up fragments of the coagulum and colored corpuscles.

Frerichs is unable to explain, by this theory, why the formation of pigment is either absent, or less marked in many other congestions of the spleen, in Typhus, Pyæmia, and simple Intermittent Fever; and why it is that the metamorphosis of the blood pigment into melanotic matter, apparently takes place much more rapidly here than at other places. He suggests that the acid character of the splenic pulp must exercise an important influence over the metamorphosis of the blood pigment.

The effects of the morbid process taking place in the splenic pulp during the action of malaria, are of a complicated nature, and we shall, upon this division of our investigations, notice only those which throw light upon the obscure and fatal form of dropsy.

The destruction of large numbers of the blood corpuscles contributes, in the first place, to the production of a state of the blood like that of chlorosis, which usually soon makes its appearance in the course of intermittent fevers. This effect upon the general mass of the blood is aggravated by the interruption of the important blood-forming function of the spleen which takes place at the same time. It is a difficult matter to determine to what extent each of these agencies is calculated to act; the loss of blood corpuscles, however, must be proportioned to their destruction, and consequently, to the quantity of pigment which has been formed.* An increase of the colorless corpuscles, as a consequence of the disease of the spleen, is not observed; in most cases the examination of the blood has shown no remarkable deviation in this respect.

The pigment originating in the spleen, passes first with the blood of the portal vein into the liver. It is here that the first functional derangements are observed. One portion of the pigment passes through the capillaries unarrested, and enters the general circulation; the larger particles remain impacted in the capillaries of the portal vein, and obstruct the circulation of the blood through these vessels. The accumulation of pigment is sometimes seen to take place chiefly at the periphery of the lobules in the interlobular veins; but at other times it extends throughout the entire capillary vascular system, and penetrates into the interior of the lobules as far as the central veins. The derangements of the circulation and their consequences vary according to the quantity of the large pigment scales and cells.

These derangements manifest themselves first in an abnormal secretion of the liver. The bile is usually secreted in large quantity, and we have repeatedly found in it considerable quantities of albumen; leucine can always be detected in the hepatic parenchyma; its saccharine constituents, however, are unchanged.

Extensive capillary stagnation gives rise to obstruction of the circulation of blood in the roots of the portal vein, which manifests itself in various ways according to its intensity. Sometimes we see exhausting hæmorrhages from the gastro-intestinal mucous membrane, coming on in intermittent manner, or more frequently profuse diarrhœas, occasionally associated with vomiting, etc., acute serous effusions into the peritoneal sac, together with bloody suffusions of the serous membrane, constitute another result; while at the later period, chronic atrophy of the liver, with its train of consequences, may make its appearance.

The next organ, in point of frequency to the liver, which undergoes important organic and functional derangements, is the brain. Numerous particles of pigment which have passed unarrested through the vessels of the liver and of the lungs, accumulate in the narrow capillaries of this organ, and particularly in those of the cortical substance. * * *

The third organ in which we observe abnormal conditions of structure and functions in melanæmia, is the kidneys. The larger pigment cells and scales which enter these organs along with the arterial blood, not unfrequently become impacted in the capillary coils of the Malpighian bodies; and by altering the pressure of the blood, give rise to derangements in the secretion of urine, which exercise a powerful influence over the further progress of the disease. Albuminuria makes its appearance to an extent which varies with the quantity of pigment found in the kidneys. In the cases where the fever has presented a distinctly intermittent type, and where, as in quartan fever, the intermissions have been of considerable duration, we have observed during each paroxysm a great increase of the albuminous contents of the urine, and during the intermissions, a marked diminution, or a complete disappearance of them. The albuminuria is frequently simple, and the process may last a long time without leading to intimate structural changes in the kidneys. But in other cases fibrinous matter passes off in the urine along with the albumen; I have repeatedly observed fibrinous casts, including pigment masses and granules of the same nature as those found in the blood; I have met with cases in which bloody urine was excreted. Complete suppression of the urinary secretion is of frequent occurrence. In cases when the secretion of albumen and fibrinous matter has lasted for a long time along with intermittent fever, or after its cessation, and ultimately has led to a fatal termination from exhaustion, alterations of comparative insignificance have been found in the kidneys. Numerous flat, scarred depressions have been observed on the outer surface of the organ, but no distinct granulations. In some cases there has been lardaceous degeneration.

With the exception of the liver, the brain, and the kidneys, in no other organ or tissue can any remarkable change of structure, or derangement of function be observed. It is true that we can detect pigment throughout the entire capillary vascular system, so far as this is filled with blood, but accumulations of this pigment, and occlusion of the capillary vessels, are only wont to take place to any extent where the smallness of the capillaries, or the peculiar nature of their distribution, impedes the free motion of the pigment scales. * *

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* The loss in this way may be considerable. Occasionally the organ, which is almost black from the accumulation of blood is considerably enlarged, diminished in its consistence, and, at some parts infiltrated with extravasations of blood.

The peculiar colour of the skin which is produced by the quantity of pigment in the blood contained in the vessels of the cutis, is of importance in diagnosis. In the slighter grades of melanæmia it is ash colored; in the more intense forms it is dirty, grayish brown, and sometimes deep yellow brown. In most cases, a few drops of blood obtained by scarification of the skin suffices to show numerous particles of pigment under the microscope. (Clinical Treatise on Diseases of the Liver, by Dr. Fried. Theod. Frerichs, New Syd. Soc., 1860, vol. 1, pp. 322–332.)

The most striking objection which meets us, in attempting to account for the changes in the liver and the dropsical effusions in certain cases of Malarial Fever upon this theory of Frerichs, that the pigment granules are the active agents in causing occlusion of the smaller capillaries, and local congestions and structural alterations, is that both the spleen and liver may be loaded with pigment granules, without any degeneration or hardening of these organs, and without even any marked derangement of health.

Two cases have come under my observation, where death was produced suddenly in *full health*, by causes other than those producing the accumulation of pigment granules in these organs, and in which there was no relation between the fatal issue and the pre-existing action of malaria, to which the patients had been subjected for varying periods.

The following are the cases:

Case 671: Augusta, Ga., July 1862. An active, strong, athletic, well formed and healthy mechanic, was assaulted by two ruffians, as he was peacefully going to his work. One of the ruffians presented a double-barrelled shot gun, which the mechanic seized with both hands, and attempted to wrest from his antagonist; one barrel of the gun was discharged within four inches of the left thigh. The discharge of the gun was not attended by immediate loss of power in the limb, and the mechanic struggled for a few moments and then fell. Upon examination it was found that the linen pants were not destroyed over the region of the discharge; whilst the cotton drawers were burned; a circular wound was discovered about two inches below Ponpart's ligament, on the anterior surface of the thigh. Blood oozed from this wound, and the skin was extensively ruffed up towards the abdominal cavity. The probe failed to pass into the wound for any distance—no shot or balls were found, and there was no well defined track indicating the passage of any hard body through the muscles of the thigh. Upon examination of the gun it was found that only one barrel had been discharged, and that the other barrel contained two loads of shot. The condition of the wound therefore, as well as the fact, that two loads of buck-shot were found in the other barrel, proved that the injury to the thigh and surrounding parts were due to the explosive force of the gunpowder alone, discharged within a few inches of the thigh.

The patient remained insensible a few moments after his fall, but soon recovered his senses. After reaction took place, the patient appeared to be doing well, but in the course of the succeeding night (the deed was perpetrated at 1 P. M., in the day,) he manifested symptoms of great uneasiness and prostration.

The next morning his countenance was pale and sunken—pulse small and threaded, with complete suppression of the urinary secretion. At 11 o'clock P. M., the patient was apparently calm, mind clear, with the exception of a slight failure of memory with reference to the length of time which had elapsed since the infliction of the injury. Expression of countenance calm; features sunken, face deathly pale and fore-head bathed with cold clammy sweat; pulse could scarcely be felt,—a mere thread, beating 160 times in the minute; in a few moments the pulse disappeared from the wrist, whilst my hands rested over the artery. Extremities cold, and the cold creeping up slowly but steadily, towards the trunk; breathing labored; action of heart rapid and thumping. He was at this time under the action of Castor Oil administered a few hours previously; had an action from the bowels during this examination, but passed no urine. The kidneys appear to have been torpid since the reception of the injury. The left thigh in the region of the wound was much discolored; blood trickled from the wound continuously. Patient complained of no pain in the wound; and during an examination, in which pressure was quite freely exerted upon the surrounding parts, did not complain of any pain. When the surrounding parts of the thigh were pressed, air issued from the wound, and it appeared to have been driven in amongst the muscles. Abdomen distended to a small extent, especially in the region of the bladder. Percussion showed that this distention of the abdomen was due chiefly to the presence of fluid. The catheter introduced into the bladder failed to bring off any water, and hence, it was concluded that the fluid was within the abdominal cavity and amongst the surrounding tissues. Lower portion of abdomen discolored.

It was evident that the life of this patient was fast drawing to a close, and in order to fulfil the demands of justice, he was informed of his true condition, with a request that he should narrate all the circumstances of the assault upon him, as a dying man, in full knowledge of the approach of death. He received the announcement with surprise, and said that he felt well, and as far as his feelings were concerned, felt that he would soon be entirely restored to health.

After calmly giving his testimony, he bade us good night, saying that he wished to sleep; the powers progressively gave way, and at 1 o'clock A. M. in the morning he died.

The body was examined by myself in the presence of the Coroner's Jury, 10 hours after death, on the 16th of July, 1862.

Autopsy, 11 hours after death. *Exterior*; height, 6 feet; weight, about 175 pounds, strong, full, well developed muscular system.

External wound elliptical; 4 by 3 inches in length, and superior border 2 inches below Poupart's ligament; extensive discoloration of inner half of left thigh, and of a large portion of the scrotum, and lower portion of abdomen. The discolored skin of the thigh, was of a deep red color, as if saturated with blood. The wound was carefully examined and dissected When pressed, numerous air bubbles, having an offensive odor issued from the wound. The muscles around the wound were extensively lacerated, and air issued from amongst their fibres and from the blood-vessels supplying them. No passage through the muscles could be found; and the wound did not penetrate into the abdomen—this fact was determined beyond all doubt, both from the thigh towards the abdomen, and from the cavity towards the thigh. The peritoneum, lining the lower portion of the abdomen, over the seat of the wound, was entire.

Abdomen.—When the abdomen was opened, the liver presented the *true slate and bronze color of malarial fever.*

This patient was cut off in perfect health, and that in a very healthy month of the year, and it is evident that he was not suffering from the immediate action of malaria. Upon inquiry I found that he had suffered with bilious fever, eight years before in Philadelphia, and after his removal to Augusta, had chills and fever several years in succession, had chills and fever last fall. This change in the color of the liver was therefore not recent, but of long standing. This case illustrates the great importance of knowing the previous history, when we attempt to decide the true nature of pathological alterations.

The intestines were greatly distended with gas, and in many parts were discolored with extravasated blood. The colon was especially discolored and injected upon the left side. The walls of the abdomen especially upon the left side, were infiltrated with blood; blood was also effused into the cavity of the abdomen. The cellular tissue surrounding the left kidney was infiltrated with blood. The left kidney was greatly congested.

Spleen enlarged, but of normal consistence in texture. It was not softened, as in recent cases of malarial fever.

This case appears to have been destroyed by the great shock to the sympathetic nervous system and the consequent arrest of the function of the kidneys. The symptoms during the last hours of life resembled those of congestive fever.

The liver presented a slate and olive color upon the exterior; and a bronze and olive green color upon the interior surface. The structures of the liver were firm; there was no special enlargement of this organ.

Numerous particles composed of conglomerated altered blood corpuscles, and pigmentary matter, and of coloring matter of the blood corpuscles, were found scattered throughout the structures of the liver. These pigmentary granules were especially abundant in the most deeply colored portions of the liver. It will be seen that these altered blood corpuscles, as well as the masses of pigment matter, resemble the altered masses of pigment and conglomerated blood corpuscles characteristic of the Black Vomit of Yellow Fever.

The spleen was enlarged to twice its natural size; but was not softer than usual; the mud of the spleen presented very much the same appearance as the blood and juices of the liver, in like manner, numerous dark red, bright red and black masses of altered corpuscles, and of pigment of the blood, were discovered in the mud of this organ.

CASE 672; *Appearance presented by the Liver, and blood of the Liver, of a Mulatto Man, who died very suddenly—so suddenly as to excite suspicions of Poisoning; History of the Case.*—Residence near graveyard, Augusta, Ga., December, 1861. He had been up all night fiddling at a "ball," at one of the disreputable houses on the outskirts of the town. He is said to have taken nothing during this time, but a glass of beer. Shortly after drinking this, he complained of feeling very unwell, and was carried home. Complained of a burning sensation and cramp in his stomach and bowels; had a copious operation; laid down, and then in a few moments afterwards, got upon the stool to have a second operation, when he fell forwards and died almost immediately. These facts were communicated to me by my colleague, Dr. L. D. Ford, who was called in at the Coroner's inquest. At the post-mortem, no special examination was made of the brain and spinal cord. No definite information was given me with reference to the appearance presented by the alimentary canal.

The liver presented, upon the exterior, a dark slate, and bronze, and purplish color. The interior presented a dark, olive, bronze color, and the blood presented very much the color of the liver, and also represented the color of the blood of malarial fever. Portions of the liver presented a mottled appearance—a mixture of the bronze, olive, Spanish brown and purplish color of the liver of health. The appearance of this liver is interesting, as resembling closely the darker shades presented by the liver in malarial fever. I was unable to ascertain definitely whether the patient had at any time suffered with malarial fever; it is, however, highly probable that he had so suffered, for his house was in a malarious district, and within a half square of the graveyard. Being a barber by trade, and having his shop near one-half mile distant, he must have been much exposed at night. This condition of the liver does not appear to have affected his health, as he was of a full habit, and very active. Besides, death occurred in the winter season, and if this state of the liver was the result of malarious influence, the effects must have been of long standing.

It is evident, therefore, from the preceding cases, that the slate and bronze pigmentary liver of malarial fever may be present, without being attended with any disturbances of health, such as those described by Frerichs, and referred to by him to the injurious action of the pigment matter.

The dropsy of the malarial fever is, without doubt, connected with the changes of the blood induced by the malarial poison, and also with the structural alterations of the spleen and liver; but that the alterations of the liver depend primarily, or wholly, or even in great part upon the mere stasis and alteration of the blood in the spleen, is not yet fully established, and it is very evident that the malarial poison exerts a direct destructive action upon the colored corpuscles both in the spleen and in the liver and kidneys.

In attempting to determine the effects of malarial fever in the production of hardening and cirrhosis of the liver, we must, in every case, eliminate the effects of intemperate habits, in altering the structures of the liver, either before or during the existence of malarial disease. By careful histories of cases, I have been enabled to show that a large proportion of the cases of malarial fever, attended with induration of the liver, occurred in those addicted to the inordinate use of ardent spirits.

Ths effects of hæmorrhage, in producing dropsy, were well illustrated by the following case, which recovered under my treatment, in Ward 24, Charity Hospital.

Case 673.—John M. Rose, age 32; native of Maryland. Admitted into Charity Hospital, Ward 24, bed 369, January 19th, 1871. Belly greatly distended by effusion into abdominal cavity. General anasarca, greatest in lower extremities. Sallow, malarious hue. Veins of abdomen turgid and arborescent. Portal circulation evidently embarrassed. Patient well built; weight 170 pounds; dark hair, dark eyes and dark complexion. Has generally enjoyed good health, with the exception of occasional attacks of chills and fever. Served in the Confederate army during the American Civil War, and, with the exception of diarrhœa of three weeks' duration, was never sick.

During 1866 and 1867, lived in Arkansas, upon the Arkansas River, and during this time suffered severely with chills and fever. Has been running upon Mississippi boats during the past four years. Twelve months ago was attacked with a severe hæmorrhage from the stomach; vomited blood and passed blood by the bowels; could not account for the attack, as he felt perfectly well, and was engaged in chopping wood with an axe at the time. Did not lose his appetite, and did not quit his work, but for the space of only one week, on account of the general debility caused by the hæmorrhage.

Patient says that he lost at this hæmorrhage "about one gallon of blood," some of which was bright red, and other portions appeared black. Had no dropsical swelling after this attack. The complexion became sallow after this hæmorrhage, and remained so up to the present time. At the time of this hæmorrhage, was not, (and had not been for some time), suffering with malarial fever.

Recovered his usual strength, and remained well, and without any disease whatever, until three weeks ago, when, on the 28th of December, 1870, whilst performing the duties of fireman, upon one of the Mississippi steamboats, was attacked suddenly with giddiness, faintness and sickness at the stomach, and in "ten minutes, vomited about two quarts of blood." The first portions of blood were black, the latter portions fluid and bright red, and clotted slowly.

Was attacked in the middle of the night, shortly after partaking of food. Became very weak, and vomited again, half an hour after, and threw up about one quart of blood in three hours after the first hæmorrhage. The blood was warm and fluid. Vomited again during the morning, about one quart of fluid blood. The patient supposes that he lost, in the course of a few hours, about one gallon of blood.

The strength was greatly reduced by these hæmorrhages, and two days afterwards the extremities and the abdomen commenced to swell, and when he came under my treatment, on the 19th of January, were greatly distended, with embarrassed respiration.

Mercurials, in the form of Calomel and Blue Mass, combined with Quinine, were persistently used, in conjunction with Cream of Tartar.

The dropsical effusion slowly and steadily disappeared, until the abdomen attained its normal proportions; and the patient regained his usual health. After the disappearance of the dropsical effusion, the liver was found to be somewhat enlarged, whilst the spleen was decidedly enlarged, forming a hard, well defined tumor, eight inches in the longest diameter.

Throughout the disease the urine was free from albumen.

After the relief of the dropsical symptoms, and the regulation of the liver and bowels, great benefit was derived from the Quinine and Tincture of Muriate of Iron mixture, and the patient was discharged at the end of two months, in his usual good health.

Case 674: *Prolonged Action of Malarial Poison; Hæmorrhage from Stomach and Bowels: Anasarca and Ascites.*—William Woods, age 22; admitted Dec. 1st, 1874, Charity Hospital, ward 30. Blue eyes, light hair, native of Pennsylvania; served in Federal Army; had syphilis about three years ago. Had chills and fever, for the first time, about four years ago. During the last summer and fall has been working in the Mississippi swamps, near Baton Rouge, La., and was sick with Malarial Fever about three months. On the 14th of November, 1874, was suddenly seized with vomiting of blood, and lost about half a gallon of blood or more during three days. Also passed a considerable quantity of blood by the bowels. Commenced to show signs of anasarca immediately after the loss of blood. When this patient came under my treatment he was in a state of extreme anæmia, the fingers appearing bloodless and almost transparent, and little or no difference being manifested between the color of the lips and gums and tongue and the sallow anæmic face; distinct anæmic murmur in heart; belly greatly distended with fluid; lower extremities distended with fluid; urine clear, light colored; low specific gravity, and entirely free from bile and albumen; no enlargement of liver detected. *Diagnosis:* dropsy resulting from prolonged action of malarial poison and hæmorrhage from stomach and bowels. *Prognosis* doubtful.

The following is the general outline of the treatment instituted in this case.

The bowels were moved occasionally by blue mass and the compound cathartic pill.

From 5 to 20 grains of Quinine were given daily, for a period of 10 days.

The Bitartrate of Potassa was administered as a diuretic and gentle purgative, one ounce mixed with a pint of water, being taken each 24 hours.

Various preparations of Iron, as the Citrate of Iron and Quinia, precipitated Iron and Tincture of the Sesquichloride, were continuously and persistently given in the usual doses, three times a day. Nutritious diet was ordered.

Under this treatment the dropsical effusion was entirely removed, the complexion improved, assuming a healthy, ruddy appearance, the strength returned, and the patient was discharged February 7th, 1875.

Cancer may give rise to dropsy from its general effects upon the constitution of the blood; but this condition must be distinguished from the ascites or watery effusion into the peritoneal cavity, which arises from cancer of the liver, the effusion in this affection being due to chronic peritonitis, extending from the liver over the peritoneum, and sometimes also, but more rarely to occlusion of the trunk or large branches of the portal vein. In 31 cases of cancer of liver observed by Frerichs, the peritoneum contained large quantities of fluid in 18; of 60 observations recorded by other authors, ascites was present in 30, in 19 it was absent, and in 11 cases no mention is made of it.

* * *

CHAPTER XIII.

DROPSY ARISING FROM DERANGEMENTS OF THE CIRCULATORY APPARATUS, ATTENDED WITH VENOUS OBSTRUCTIONS AND CONGESTIONS, INCREASED SEROUS EFFUSION FROM THE DISTENDED BLOOD-VESSELS AND DIMINISHED ABSORPTION.

CARDIAC DROPSY RESULTING FROM STRUCTURAL ALTERATIONS OF THE HEART AND LARGE BLOOD-VESSELS. CARDIAC DROPSY; DILATATION OF HEART; DEATH. CARDIAC DROPSY. DILATATION OF HEART; GENERAL ANASARCA; DEATH. DILATATION OF CAVITIES OF HEART; UNIVERSAL DROPSY. ARTICULAR RHEUMATISM; VALVULAR DISEASE. ANEURISM OF INTERNAL ILIAC. ANEURISM OF DESCENDING AORTA. ANEURISM OF ASCENDING AORTA. ANEURISM OF ARCH OF AORTA. ANEURISM OF ARCH OF AORTA AND ASCENDING AORTA; DILATATION OF HEART. TREATMENT OF CARDIAC DROPSY.

UNDER this head may be classed Cardiac dropsy, resulting from structural alterations of the heart and large blood-vessels; and Hepatic dropsy, resulting from certain diseased states of the liver, and sometimes accompanied by enlargement and induration of the spleen.

CARDIAC DROPSY, RESULTING FROM STRUCTURAL ALTERATIONS OF THE HEART AND LARGE BLOOD-VESSELS.

In the first stages of heart disease, the constitution is as a general rule unaffected, and apart from certain local phenomena and physical signs, and slight dyspnœa and palpitation, the general health appears good.

Owing to the continuous disturbance, however slight, at first, of the circulation and respiration, the dyspnœa and palpitation increase, the nutrition of the body is impaired, the general health progressively deteriorates, and a slight amount of œdema appears in the lower extremities.

As the disease progresses there is not only a progressive aggravation of the affection of the heart, but also, as a direct effect of the disturbances of the respiration and circulation, a great increase of dyspnœa and dropsy.

In the last stage of cardiac disease, in which the patient is doomed to speedy death, the countenance assumes a yellowish white, cachectic appearance, and the dropsy in many cases becomes general.

Although cardiac dropsies appear in most cases to be preceded immediately by venous congestion, we should not refer the dropsical effusion to this cause alone, for it appears to be referable, to a certain extent at least, to the progressive alteration of the blood and derangement of nutrition caused by the disturbance in respiration and circulation. The blood is not properly oxygenated, the carbonic acid is not properly eliminated, and the organs and tissues are not only supplied by an imperfectly elaborated blood, and that too in an irregular manner, but the office of important organs, as the kidneys and liver, is in turn deranged.

This symptom of cardiac disease is usually, therefore, of late occurrence, making its appearance almost invariably about the ankles and feet, as slight œdema, and by slow degrees ascending towards the trunk, and ultimately involving the upper extremities and face. The anasarca commencing in the feet and gradually proceeding upwards, precedes the ascites, and even when the belly becomes swollen, the swelling of the legs is large, and out of all proportion to the ascites.

According to Dr. Walshe, dropsy, sequential to heart disease, occurs in the following situations, enumerated in the order of frequency with which they severally suffer; the sub-cutaneous cellular tissue; the pulmonary parenchyma; the peritoneal and pleural sacs; the pericardium; the cerebral and spinal arachnoid and sub-arachnoid spaces; the tunica vaginalis; the joints and the eyeball, especially the aqueous chambers. But in the last three situations, dropsy is excessively rare.

Dr. Latham has justly observed that the first appearance of the dropsy, marks an eventful period in the progress of cardiac disease. It indicates that a new law takes effect in the circulation, and gains the mastery of the law of health, which has hitherto been able to retain the watery elements of the blood-vessels, now the serum escapes and accumulates in the areolar tissue of the body.

The forms of valvular disease, as laid down by pathologists in the order of the frequency in which dropsy is met with, are: (1), Considerable contraction of the left auriculo-ventricular orifice; (2), Dilatation of the auriculo-ventricular orifice, with hypertrophy and dilatation of the right ventricle; (3), A state of the mitral valve and orifice permitting free regurgitation; (4), Considerable contraction of the aortic orifice. As a general rule, cardiac dropsy supervenes earlier, the earlier that venous congestion ensues. The establishment of a varicose condition of the blood-vessels in the air-vesicles of the lungs, essentially aggravates the dyspnœa. When the dropsy is carried to great amount, erythema, erysipelas, and even sloughing are prone to occur; the skin cracks, the serous fluid oozes more or less copiously.

Dr. Walter Hayle Walshe, in his valuable "*Practical Treatise on the Diseases of the Heart and Great Vessels*," gives the following important observations upon the nature and causes of dropsy and serous flux of cardiac origin:

(a.) *Systemic Form.*

Dilatation was formerly regarded as the condition of the heart mainly inducing the important class of dropsical symptoms. This opinion discountenanced by M. Brouillaud, who sought to establish valvular obstruction as their sole efficient cause, was restored to favor by Hope and M. Andral—the former of whom indeed went the length of teaching that pure hypertrophy, also, was capable of generating dropsy. Of late, Dr. Blackiston has brought together a body of evidence calculated to show that the systemic vessels do not become loaded in cases of dilatation, unless there be co-existent tricuspid regurgitation. Still more recently Dr. H. Douglas has defended the original thesis of our forefathers. It becomes necessary for me to express an opinion on this "vexed question" of the mechanism of cardiac dropsy; let me commence by throwing into a series of propositions such inferences as flow directly from facts that have fallen under my own notice.

1. Mitral regurgitation or obstrnction, or aortic regurgitation or obstruction, may severally exist, and, for a lengthened period, without systemic dropsy supervening. 2. Mitral regurgitation and aortic regurgitation may co-exist for years, and yet no dropsy occur. 3. Both of these propositions hold good, whether notable hypertrophy do, or do not, exist behind the obstruction. 4. Simple hypertrophy of the left ventricle may reach the highest point without systemic congestive effects of kind arising. Dr. Hope, as is well known, maintained the reverse, holding that pure hypertrophy, if protracted, will produce general dropsy; but he gives no cases demonstrating the facts, and the motives of his belief are, as far as he shows, totally speculative. And *a priori* views are not so completely in his favor as he appears to imagine; when he talks of the "increased force of circulation surmounting the natural tonic power of the capillaries," he forgets that that very tonic power may have increased *pari passu* with, and in consequence of, the growth of the hypertrophy. The question is one of observation; and I have stated what I have actuatly seen in persons who had not been reduced by treatment to a state of anæmia. 5; Dilated hypertrophy, even of the left ventricle may last for years without any such effect, provided the dilation be not in notable excess. 6. The heart may be in a state of advanced fatty metamorphosis, the pulse feeble and infrequent, the encephalic and respiratory functions exhibit the singular perversions attending a high degree of the disease, the entire organism betray functional languor and inactivity, and yet even the prætibial integuments fail to pit in the least under pressure. 7. Or the heart may be soft and flaccid and the pulse persistent, frequent, feeble, and irregular in force and rythm, and yet no systemic congestions occur. 8. The natural relationship of width of the arterial orifices, and also of the auriculo-ventricular orifices, may be materially perverted, without the least systemic dropsy arising, until the closing days of life. This is seen, for instance in cyanotic cases where the aorta and pulmonary artery are transposed in origin, the relationship of the great veins to the two sides being normal. Similar evidence is often afforded by cases of aneurism of the arch of the aorta with an orifice more or less widely dilated, so as to exceed that of the pulmonary to variable amounts. 9. Tricuspid regurgitation where the right ventricle is in a state of dilated hypertrophy, as shown during life, by swollen and pulsatile

veins, which fill from below and as shown after death by actual examination, does not
rily produce dropsy. Besides if tricuspid regurgtation sufficed unassisted, on
ical principles to produce systemic dropsy, why should not constriction of the pulmo-
ifice, so frequent in cyanosis, habitually engender it.

propositions are, I believe, incontrovertible; they are the mere general expression of
ich are perpetually occurring. I cannot, then, see how the conclusion is to be avoided
mething beyond and in addition to any one, or any group, of the cardiac conditions
to, is required in order, as matter of necessity, to entail the occurrence of dropsy. I
cely suppose the unwarranted assumption that, were life sufficiently prolonged, these
ns would of themselves suffice for the purpose, would be seriously urged in rejoinder.
in, the existence of some acting cause beyond, and independent of the heart, is farther
y the facts: that there is no direct relationship between the amount of heart disease
dropsy; that dropsy comes on suddenly sometimes from extraneous causes, the state
eart remaining, as far as ascertainable, in precisely its previous condition; and that
diminishes and increases, comes and goes, either spontaneously or through the influ-
treatment, while the organic changes in the heart remain permanent and unmodified.
must not, however, run into the opposite and equally erroneous extreme of wholly
g the direct influence of organic changes of the heart and its orifices. Two cardiac
ns are, as matter of experience, frequently associated with systemic dropsy—namely,
on and tricuspid regurgitation. And it is certainly so rare for either of these states to
r any length of time without the surpervention of such dropsy, that any hypothesis
tory of cardiac dropsy, must look to these states as forming important links in the
f causes.

re in the direct mechanism of systemic dropsy being thus conceded to structural
in the heart, the question next arises what is the nature of the influence, independent
organ, which completes the causation. Local conditions in the heart we admit estab-
ifficulty in the systemic circulation; what influence actually and directly leads to the
al exosmosis?

nfluence seems a compound of conditions, favorable to transudation of the serosity of
d, in that fluid itself, in the walls of the capillaries and venous radicles, and in the
g tissues.

as concerns the blood, the influence of an impoverished state of that fluid is too well
to be for a moment contestible. Experiments on animals prove that if the veins be
less loaded with water, they yield this in the form of dropsical effusion. The œdema
etimes extensive anasarca of spanæmia; the slight œdema attending the hypnosis of
ed convalescence from various acute diseases; the various dropsy of uremia—are all
ions in point. Obviously morbid states of the blood, when of the proper kind of
ves, alone suffice for the production of dropsy; look at the sudden anasarca of acute
disease, or of an acute recrudescence in the chronic affection, while the heart, liver
ngs, may be texturally sound. *Secondly*, it is readily conceivable that the variable
of texture of the walls of the vessels may promote or restrain the process of filtra-
Thirdly, cases occasionally present themselves, in which dropsy supervening from
d heart, fails to affect portions of the body, noted under ordinary circumstances, as the
and readiest sufferers—for instance the lower extremities. I have observed this where
s had been the seat of erysipelas and subcutaneous inflammation prior to the occur-
f the cardiac dropsy; the chronic anatomical change in the cellular tissue in such a
ssibly acts as a barrier to its reception of serosity from the vessels.

ay no doubt be argued *a priori*, that dilatation of the heart occurring as a primitive
through simple weakness, or following actual structural alteration of the texture of
an, will occasionally prove the efficient cause of dropsy, even admitting the necessity
od change, just contended for. It may be urged that when the heart is so affected, the
ary *vis a tergo* in the circulation is wanting, and capillary stagnation must ensue—and
is very stagnation, becoming habitual may modify the qualities of the blood, and im-
nutrition of the walls of these vessels through the strain they suffer. But plausible
this argument may be, I believe as matter of experience, that the necessary change in
nposition of the blood is meanwhile really worked out by other and more effective
s.

since Lower showed that local dropsy might be produced by ligature of veins; and
urrence of serous effusion from local obstruction of vessels of that class is clinically
nown. But here are instances of sudden and limited obstruction; they are evidently
gically comparable with cases of slow and centric obstruction. And even where the
ty in the way of the returning blood is purely local, it does not necessarily follow that
lation shall occur from the communicating venous radicles, although the evidences of
ed condition of these vessels be structurally obvious. Thus in case of aortic aneurism
ng one or both innominate veins, the capillaries of the base of the neck may dilate in such
er as to produce notable general swelling at the spot, yet not a particle of œdema be
nible.

(*b*) *Visceral and Intra-Serous Form.*

Pulmonary œdema is chiefly connected with disease, constrictive or regurgitant, of the sometimes with dilatation of the left ventricle, very rarely with hypertrophy of the *Ascites* arises especially from general dilatation of the heart and tricuspid regurgitation; these are the conditions mainly observed, as antecedents to all the other varieties of enumerated.

B.—Cardiac Flux.

(a) The intestines become the seat of serous flux in some rare instances of certain of heart disease. Watery diarrhœa thus induced may be wholly spontaneous, or the excitant of the discharge may have been some hydragogue purgative, the influence of holds on.

* * *

(b) I believe that in some of those cases, where vomiting forms so obstinate a sym chronic heart disease, the immediate cause of the nausea is the presence of an in watery secretion from the gastric surface. It is never very copious.

(c) Watery flux from the kidneys, though on the whole not very rare, is uncertain occurrence, doubtful in its mechanism, and cannot be said to belong to any particular affection. For my own part I have seen passing attacks of hydruria more frequently in nection with different forms of dynamic disturbance, than with any specific organic * * Here the rationale is the same as in the case of hysterical diuresis; and so long immediate mechanism of the latter continues in its present obscurity, we must ignorance of that of the former.

Albuminuria occurs every now and then in cases of cardiac disease, especially of and tricuspid insufficiency, the tendency of which is to congest the viscera. The cortical tubular substances remain texturally sound. The character of this form of albumin are as follows: it is a passing phenomenon, sometimes disappearing spontaneously, yielding to treatment; the albumen is always small in amount; the specific gravity of fluid never falls very low, its color remains unaffected and its smell wholly free from whey-like odor to which I long since drew attention as notably significant of Bright's A few casts of the latter occasionally appear.

The researches of pathological chemists have shown that in the early stage of heart disease, marked merely by the local phenomena, a few physical signs, and amount of dyspnœa and palpitation, the proportion of water increases, and the gravity of the blood consequently diminishes; the globules decrease somewhat, mean being represented by 125; the fibrin remains unchanged; and lastly, the men contained in 1000 parts of serum undergoes a trifling diminution, proport that of the globules, its mean being represented by the figures 71.05.

As the disease progresses, the physical signs become more clearly defined, the symptoms more marked, and the general health begins to fail, and the consti evince signs of deterioration, and the face becomes anæmic, and the lower slightly œdematous, the specific gravity of the blood and serum becomes lower, the portion of water increases, the globules undergo still further diminution, their being represented by 117, the fibrin augments in many cases, and lastly, the decreases, like the globules, its mean proportion in 1000 parts of serum being The dropsy is indicated at its onset by a decrease of the albumen of the blood.

When the disease has reached an advanced stage, with severe palpitation dyspnœa, considerable serous infiltration invades the pleural and peritoneal cavities, as the sub-cutaneous cellular tissue. Under these circumstances, the blood, for the part, undergoes great modifications, of which the following is a general outline:

The amount of water is greatly increased, whilst the specific gravity and soli ters of both the blood and serum are proportionally diminished. The blood and the albumen, and especially the latter element, undergo very considerable The decrease of the albumen of the serum is consecutive to the dropsy, only place when the latter becomes well marked. The decrease of the albumen referred to the impoverishment which the blood undergoes, by reason of the serum, constituting the dropsy. Becquerel and Rodier very justly conclud their analysis of the blood in cardiac dropsy, that, when the blood has becom erished by the occurrence of mechanical dropsy, it is probable that infiltratio with increased rapidity, and that the serum, even more watery than heretofo with greater facility, under the influence of two causes acting in the same dire

npediment to the circulation, and the diminution of the solid matters of the
.

following cases of cardiac dropsy, have been selected from those observed in our
n the Charity Hospital.
nic diseases of the heart and great vessels, although constituting, relatively, a
roportion of the diseases treated in military, civil and hospital practice, at the
me, the ratio of mortality is comparatively great.
, in a total of 2380 cases of various diseases, which I treated in the Charity
l, during a period of 45 months, the total deaths were 235. During this
41 cases of organic disease of the heart and great blood-vessels were treated, with
ths, giving a mortality of 34.14 per cent., and a ratio of one death in 2.95 cases.
llowing are the cases and results, as entered upon the Case Book: Organic Dis-
Auriculo Ventricular Valves, with Hypertrophy and Dilatation of Heart, 9 cases,
s; Organic Disease of Auriculo Ventricular Valves, with Dilatation, 5 cases, 2
; Hypertrophy, 1 case: Hypertrophy, with Dilatation of Arch of Aorta, 3 cases,
h; Dilatation and Fatty Degeneration, 3 cases, 1 death; Fibrous Concretion,
ide, attached to Chordæ Tendinæ, and Carneæ Columnæ, and Tricuspid Valve, 1
death 1; Palpitation and Irregular Intermittent Action of Heart, cases 4
ism of Ascending Aorta, 2 cases, deaths, 1; Aneurism of Ascending Aorta;
of Aorta, and Descending Aorta, 3 cases, 1 death; Fatty and Calcareous
ration of Coats of Aorta and Semilunar Valves, with Dilatation of Left Ventri-
Auricle, 1 case, death 1; Insufficiency of Mitral Valve, with Dilatation of Left
and Ventricle, cases 6, deaths 2; Insufficiency of Aortic Valves, 3 cases, 1

675: *Cardiac Dropsy; Hypertrophy of Heart; First stages of Cirrhosis of Liver.*—In this
e students were enabled to watch the gradual progress of the disease to a fatal issue.
bserve the gradual aggravation of the heart symptoms and the origin and increase of
eral anasarca.
s Duncan, age 30 years: height five feet, nine inches; weight 135 pounds; dark hair,
es, dark complexion; native of Ireland; six years a seaman, and fifteen years a boat-
the Mississippi river. Twelve years ago he had several attacks of chills and fever;
ix years ago, and finally, during the fall of 1868.
een months ago, the patient says, that he was working in the hot sun, and drank large
ies of cold ice-water, when he was attacked suddenly with an affection of the heart,
asted several days; six months afterwards was attacked in a similar manner, and spit
d.
s intemperate at times; previous to the late civil war, drank regularly, but not to
tion; entered the Southern service, and drank but little during the war. Since the
ed alcoholic stimulants freely to relieve the pain in the region of the heart. At first,
mulants gave comfort, and he consumed large quantities, even to intoxication.
, however, before entering the hospital, the stimulants appeared to aggravate the dis-
d the patient gave up steady drink. Suffered severely the week before entering the
.
tted into the Charity Hospital, ward 18, bed 267, March 9th, 1869. At this time, the
was suffering with great pain in the region of the heart, soreness and pain in the
ic region, and along the abdomen in the region of the liver, extending on either side,
hypochondriac regions. Bowels irregular and constipated. Appetite pretty good,
ndisposed to exertion, but not confined to bed.
ment consists in the administration, three times a day, of ten drops of Tincture of
, and the same quantity of the Tincture of the Sesqui Chloride of Iron.
5th, 1869.—Patient takes gentle exercise during the day, walking around the ward
, but suffers debility from muscular exertion; came under my treatment at this time
following results of physical exploration were then recorded:
ultation and percussion revealed enlargement and dilatation of the heart; the dull
ver the region of the heart being at least twice as large as in health. The beat of the
lower down and more to the right than normal; and the impulse, as communicated
hand placed upon the wall of the thorax, is different from that of health, giving the
ion of the impulse of a large, soft, quivering bag, against the thoracic walls. The space
walls of the thorax against which the apex of the heart is propelled, appears to be at
ree times the ordinary size of health. The first sound of the heart is entirely altered

being converted into a loud, blowing sound, much more distinct upon the left side, and over the region of the left auriculo-ventricular valve, near the junction of the cartilage of the fourth left rib with the sternum. This loud cardiac murmur was heard at the apex of the heart and along its body, becoming most distinct over the region of the auriculo-ventricular valves, in the middle of the sternum, in a line with the articulation of the cartilages of the fourth ribs with the sternum, and gradually diminishing towards the base, and becoming quite indistinct over the position of the semilunar valves of the aorta and pulmonary arteries near the junction of the third ribs with the sternum. At the apex of the heart, the second sound was heard with difficulty. At the base of the heart, or rather about the region of the arch of the aorta and the arch of the pulmonary artery, above the line joining the cartilages of the third ribs with the sternum, the first sound was heard with difficulty, or rather it became indistinct. The second sound of the heart was loud, sharp and metallic, with a slight roughness prolonged in the direction of the aorta. Some dullness upon percussion over region of lungs. No physical signs of either tuberculosis, or pneumonia, or of pleurisy, were detected. The congestion of the lungs was referred to mitral regurgitation. The veins of the neck (external jugulars), gave a distinct venous pulse.

The liver was enlarged, and tender to the touch. Slight effusion into the abdominal cavity, and œdema of face and extremities, especially marked in the feet and ankles, complexion sallow, wax-like, with slightly jaundiced hue. The yellow, jaundiced hue was especially distinct in the eyes. Urine scanty, high colored, high specific gravity, and loaded with biliary acids. The urine contained no albumen or urinary casts.

Bowels irregular, most generally constipated. Appetite poor; tongue coated with whitish colored fur. Pulse feeble, 80 per minute; respiration 22; temperature under axilla in the morning, 99° F. Sp. gr. of urine, 1023.

The diagnosis established by this examination was—

Enlargement and Dilatation of Heart.

Regurgitation of Blood from Auriculo-Ventricular openings.

Roughness in the Aorta, beyond the Semilunar Valves.

Congestion of the Lungs and Venous Pulse, in consequence of Regurgitation of Blood through both Left and Right Auriculo-Ventricular openings.

Absence of Active Inflammation or Tubercles from Lungs.

Cirrhosis of the Liver in the early stage, in which the organ is increased in size.

The patient was treated with small doses of Calomel and Sulphate of Quinia, with occasional saline purgative, with no perceptible benefit. The heart trouble increased, the spitting of blood became quite common, and the œdema of the extremities, and dropsical effusion steadily increased. Tincture of Wild Jessamine (Gelseminum Sempervirens), was also effectually tried, as well as Tincture of Digitalis, but without any perceptible beneficial effect, and in fact the latter remedy appeared to do harm rather than good, by its depressing effects upon the action of the heart, and its debilitating effects upon the nervous system.

Nitro-Muriatic Acid administered internally, and also in the form of foot-bath, appeared to afford more relief.

The failure of strength appeared to be quite gradual, and the patient finally became much swollen, the effusion in the abdominal cavity increased, the venous congestion became more marked, with distinct pulsations of the jugular veins and blue lips; the difficulty of respiration became so great, and the action of the heart so irregular, that the patient could not rest at night, and was compelled to sit up in bed. The forces failed progressively, and he died on the 15th of June. The following is a tabular statement of the more important symptoms:

DAY OF MONTH	HOUR OF DAY.	PULSE.	Respirat'n	TEMPERATURE OF AXILLA.	STATE OF INTELLECT, TONGUE, BOWELS, APPETITE AND COMPLEXION.	CHARACTER OF URINE.	REMARKS UPON GENERAL SYMPTOMS.
April 6	9 A. M.	92	22	99°	Intellect clear; bowels constipated; no appetite; dark and jaundiced complexion.	Scanty, high color. Sp. gr. 1025.	Patient complained of great soreness and tenderness in abdomen, especially in region of liver.
" 7	9 A. M.	92	22	99°	Condition same.	Same character. Sp. gr. 1025.	Still complains of soreness; vomiting, no appetite, some fever in the evening.
" 8	9 A. M.	98	26	100°	White coating on tongue; action on bowels.	Scant, high color. Sp. gr. 1025.	Patient says that he feels better, with less abdominal pain than yesterday.
" 9	9 A. M.	88	22	99°	General symptoms same; feels better.	Sp. gr. 1025.	A little more comfortable.
" 10	9 A. M.	86	22	98°.5	Appetite better. Tongue coated.	Amount of urine f. oz. xv. Sp. g. 1025.	Feels a great deal better with almost total absence of pain in abdomen and epigastric regions.
" 11	9 A. M.	86	22	99°	Improving.	F. oz. xxvii. Sp. gr. 1015.	Continues the same. Purgatives administered.
" 12	9 A. M.	87	22	99°	Bowels constipated.	F. oz. xxx. Sp. gr. 1015.	Bowels opened by Comp. Cathartic Pills.
" 13	9 A. M.	87	22	99°	Bowels opened.	F. oz. xxx. Sp. gr. 1015.	Not so well as yesterday. Breathing oppressed.
" 14	9 A. M.	88	21	99°	Same condition.	F. oz. xxvi. Sp. gr. 1015.	Has been spitting blood for several days. At times great oppression in breathing.
June 8	9 A. M.			100°.5	Jaundice; constipation of bowels. Tongue coated.	F. oz. xvi. Sp. gr. 1030.	Nausea and spitting of blood; soreness over region of liver. Ascites. Anasarca of extremities greatly increased. Cannot lie down in bed. Great oppression of breathing.
" 9	9 A. M.	110	26	99°	Bowels constipated. Jaundice. White of eyes yellow.	Only f. oz. iv. collected; high colored and loaded with bile.	Spits blood. Great congestion of veins of neck. Purple lips and fingers. Great oppression in respiration. Exhausted and feeble. Loud distinct bellows sound taking the place of the first sound of the heart. Roughness in second sound.
" 10	9 A. M.	112	26	100°.5	Two small stools.	Urine high colored, scanty and loaded with bile. No albumen or casts.	
" 11	9 A. M.	110	20	100°.5	Tongue coated. patient feeble and depressed; pulse weak and thready.	Urine scant, high colored and loaded with bile.	Great exhaustion and dyspnœa.

The forces progressively failed, although the patient was able to converse when propped up in bed, almost up to the last moment of life, and died suddenly at five A. M., June 15th.

The *Post-Mortem Examination* was performed six hours after death.

Exterior.—Surface of a yellow jaundiced hue and with dark mottling of blood in the dependent portions. Abdomen and lower extremities considerably swollen from serous effusion.

When the thorax was opened, the lungs did not collapse to any marked extent. The lungs were greatly congested with blood. The marks of the hæmorrhages were visible in various portions of the lungs. The effusions of blood had transformed the pulmonary tissue into a dark, liver-like, hard substance.

The lungs contained no tubercles, were not softened, and gave no evidence of pulmonic or pleuritic inflammation.

Heart.—The pericardium was adherent to the sternum upon the anterior aspect.

The heart as it lay in its natural position, presented an enormous size, and was distended in all its cavities with black fluid blood.

The heart contained at least one pint of black fluid blood, and it appeared as if the patient had died from the want of power in the walls of the heart to contract upon the blood distending its cavities.

The left auricle and ventricle were enormously dilated; the right auricle and ventricle were also dilated, but not to so great an extent. There was an appearance of partial fatty degeneration in some portions of the heart, and the muscular structures generally of the heart were softer than normal.

The auriculo-ventricular, and aortic and pulmonary valves, were not thickened nor altered in structure, with the exception of some insufficiency of the mitral valve. The auriculo-ventricular openings, however, were so much altered, in being greatly increased in size, that the valves were insufficient.

The length of the heart after being placed in alcohol, and after considerable contraction, was six and a half inches, the breadth five inches, and the circumference eleven and a half inches.

The walls of the aorta and pulmonary artery, beyond the semi-lunar valves, were roughened by calcareous and osseous deposits. These deposits accounted for the rough sound succeeding or rather flowing from the first sound.

Liver, cirrhosed, enlarged, with some fatty degeneration. Surface of liver presented a yellowish bronzed mottled color.

Microscopical examination, revealed increase of fibrous tissue, and oil globules, together with numerous fragments of hæmatin. The masses of hæmatin scattered through the texture of the liver, gave the dark mottled bronzed appearance, and were most probably deposited during the previous attacks ef Malarial Fever.

Kidneys, congested, but normal in structure.

In the preceding case, the dilatation of the heart appeared to have been due in a manner to the same causes which induced softening and fatty degeneration of the muscular fibres of this organ and of the cells of the liver.

In the following case the symptoms of heart disease, although severe, have been relieved partially or mitigated by treatment.

CASE 676: Daniel Dunn, aged 46 years; height five feet six inches; weight 176 lbs. in health; large, well developed chest and limbs, large head and intelligent countenance; dark hair, dark blue eyes and dark complexion; native of Ireland; occupation fireman on steamship. Has no hereditary tendencies, and has always led an active life; served in the Southern army during the recent war, and was wounded five times; left leg fractured by Minnie ball; flesh wound of posterior portion of upper third of thigh, flesh wound of right hip, another wound on the instep, and still another on the anterior part of the thigh, two inches below Poupart's ligament. Had repeated attacks of intermittent fever, during 1857, 1858 and 1859, and was affected with sunstroke on the 4th of July, 1863.

During the summer of 1868, suffered with pain in the region of his heart, attended with anasarca, pain in the head, loss of muscular power, and difficulty of breathing. Admitted into Charity Hospital, October 19th, 1868. At the time of his admission was suffering with anasarca, cephalalgia, muscular debility and irregular and imperfect action of the heart.

The treatment consisted of tonics, nutrition, diet, and the free use of diuretics. Under this treatment his general condition improved.

At the time this patient came under my treatment in March, 1869, his complexion was sallow, anæmic, and of a yellow, wax-like hue. Temperature normal; pulse 76; respiration 20. Lower extremities œdematous. Some œdema about face and upper extremities. Urinary secretion abundant. Patient complains of pain in his head, and of weakness upon any unusual exertion. Action of heart abnormal, a murmur being heard with the first sound.

having its maximum intensity at the position of cardiac impulse. The anasarca has been greatly reduced by the persistent use of diuretics, and especially by the cream of tartar and Juniper berry infusion and mixture. Tincture of bark and preparations of iron, and especially the tincture of the sesquichloride, appear to have been most beneficial in maintaining the strength of the patient. The following observations give a correct view of some of the leading symptoms in this case. April 7th, 9 A. M., respiration 20; temperature of axilla 98°; tongue clean, bowels regular, complexion sallow, anæmic, urine abundant, œdema of extremities and of face; spirits good, assists in nursing the patients. April 8th, 9 A. M., pulse 86; respiration 22; temperature of axilla 98°.5, sp. gr. of urine 1020. April 9th, pulse 92; respiration 21; temperature of axilla 99°.5; urine abundant, one hundred and forty ounces (140 ozs.) being passed during the last twenty-four hours; sp. gr. 1010. The urine was carefully tested upon this occasion, as it had been upon others, for grape sugar and albumen, but no traces of these substances were detected. April 10th, 9 A. M., pulse 92; respiration 21; temperature of axilla 99°; urine excreted during twenty-four hours 100 fluidounces, sp. gr. 1010; no grape sugar nor albumen. April 11th, 9 A. M., pulse 88; respiration 22; temperature of axilla 98°.5; amount of urine 100 fluidounces, sp. gr. 1010. April 12th, 9 A. M., pulse 88; respiration 22; temperature of axilla 98°.5; amount of urine 100 fluidounces; sp. gr. 1010. April 13th, 9 A. M., pulse 88; respiration 20; temperature of axilla 98°.5; amount of urine 100 fluidounces; sp. gr. 1010. April 14th, respiration 20; temperature of axilla 98°.5; amount of urine 100 fluidounces; sp. gr. 1010.

At the time of the entrance of this patient into the hospital, the anasarca was very great and troublesome, but it yielded and was held in abeyance by the action of diuretics.

Neither albumen nor grape sugar were detected in the urine.

The dropsy in this case appeared to be the result of the cardiac disease, and the anæmic state of the blood.

CASE 677: *Dilatation of Heart; General Anasarea; Death.*—Hannah Clark, colored woman, age 40. Entered ward 34, bed 517, Charity Hospital, September 19th, 1869. Patient lies on her back utterly prostrated, with apparent complete muscular and nervous exhaustion. Universal anasarca; abdomen and extremities, and head swollen from dropsical effusion. Action of heart very feeble; impulse of heart can scarcely be felt. Great dullness upon percussion over region of heart; and the area of dullness at least four times as great as that usual in the healthy thorax. Dullness upon percussion over both lungs; dullness most marked over the lower dependent portions of lungs. The dullness is so great over the lower portions of the thorax as to indicate pleuritic effusion. Upon auscultation, the sounds of the heart are indistinct and feeble. Diagnosis: dilatation of both sides of the heart, and general dropsy as the result of cardiac disease.

The patient is evidently in extremis. Oppression of breathing so great that the patient is unable to articulate with any force, and it is difficult to understand her broken sentences.

Patient died September 21st, two days after her admission into the ward.

Autopsy twelve hours after Death.

Exterior.—Trunk, abdomen and extremities greatly swollen. Areolar tissue everywhere infiltrated with serous fluid. On opening the cavity of the thorax, a large amount of serous fluid filled the pleura, and occupied a large portion of the space usually filled by the lungs. The right lung was compressed into a mass not larger than a man's hand, and presented a hepatized appearance, and apparently had lost the power of dilatation. The left lung was also compressed into a comparatively small space, but was readily dilatable when removed from the pleural cavity. The heart was enormously enlarged, measuring seven and three-tenths inches in length, and fifteen and a half inches in circumference, as it lay in the thorax with the auricles and ventricles immensely distended with black blood. The blood was partially coagulated, and the coagula were readily divisible into two portions, the one ordinary blood and formed post-mortem, and the other light yellow, fibrinous, and formed ante-mortem. The fibrinous clots were to a great extent, stripped of colored corpuscles, and adhered closely to the valves and chordæ tendinæ. The walls of the heart were thin and not hypertrophied.

The edges of the mitral valve were thickened and from the deposits of calcareous or osseous matter; or rather from the deposit of fibrin in some preceding attack of rheumatic endocarditis, which had been gradually transformed into an inorganic hard mass.

Spleen, liver and kidneys, healthy in appearance. Intestinal canal also normal in appearance. Some small loose fibrinous clots floated in the serous fluid of the pleura and peritoneum; and a small patch of fibrinous exudation was observed on the surface of the descending colon, in the lumbar region.

The origin of the cardiac disease and the supervening dropsy appears to have been the deposit of fibrinous matter upon the auriculo-ventricular valves in some former attack of rheumatism, thus causing auriculo-ventricular regurgitation.

CASE 678: *Dilatation of Cavities of Heart; Universal Dropsy; Death.*—John Wilson, negro man, aged 57, stout, well-built man, native of Virginia. Admitted to Charity Hospital, ward No. 32, September 2d, 1868.

Patient says that he has always enjoyed good health up to December, 1868, when he was seized suddenly with palpitation of heart, and great difficulty of breathing. Has been admitted several times into the Charity Hospital, since this date, suffering with palpitation of the heart and dyspnœa. As soon as some slight improvement took place, under rest and diuretics and tonics, the patient would ask to be discharged.

At the present time, September 2d, the patient suffers with great dyspnœa, pain in the region of the heart, dry hacking cough, general anasarca, which however is less in the right arm and head.

The apex beat of the heart is just below the nipple; space of percussion dullness over region of the heart greatly enlarged. First sound of heart prolonged and attended with a distinct regurgitant murmur. Second sound normal. Diagnosis—Dilatation of both sides of the heart, with auriculo-ventricular regurgitation. General dropsy and dyspnœa consequent upon heart disease. No albumen or bile was found in the urine. Diuretics and tonics were administered, with only temporary benefit, however, as the anasarca increased as well as the oppression of breathing; the lower extremities became immensely distended; the patient was unable to lie down, and finally died twelve days after his admission, on the 14th of September.

The post-mortem examination revealed a similar condition to that described in the preceding case No. 677. Universal anasarca—liver and kidneys and intestinal canal healthy. Heart greatly dilated and distended with black blood. The dimensions of the organ were fully equal to those given in the preceding case. The mitral valve was thickened with osseous deposit.

The auricles and ventricles were greatly dilated, and the auricular ventricular opening so much enlarged as to render the valves insufficient, and to allow regurgitation of the blood, during the contraction of the ventricles.

The following case illustrates the fact that we may have decided evidence of insufficiency of the aortic valves, without dropsical effusion.

CASE 679: *Articular Rheumatism, with derangement of Second Sound of Heart.*—Wm. Rogers, seaman, aged 21 years, stout, well formed man; admitted into Charity Hospital, ward No. 11, bed 154, January 20th, 1870, suffering with chronic rheumatism, affecting chiefly the upper extremities. Patient states that seven years previous to the present attack, he was confined to his bed six or eight weeks by rheumatism, which affected chiefly the upper extremities. The attack was brought on by exposure. Two years afterwards he had a second attack, which was confined to the parts and joints of the lower extremities; and at this time he suffered severe pain in the left side, which his attending physician pronounced to be due to pleuritis, with palpitation of the heart. The present attack came on in November, 1869, with pain in the wrists, joints and hands, and finally affected the shoulder joints. On percussion the heart appears to be hypertrophied; and upon auscultation the second sound is entirely altered, being converted into a prolonged, blowing sound, heard loudest at the base of the heart over the aortic and pulmonary valves, and is transmitted up as high as the point of bifurcation of the common carotid artery. The sound is loud and distinct. The patient was placed on a mixture of Wine of Colchicum, and Solution of Iodide of Potassium, so compounded that eight drops of the Wine of Colchicum and five grains of the Iodide of Potassium should be administered three times a day. Iodine was also used locally, and the parts covered with cotton and oil silk. Under this treatment the patient steadily improved, and was discharged from the ward on the 26th of February, 1870.

It is worthy of note in this connection, that the most extensive aneurism may exist, without the production of any dropsical effusion. If the aneurism presses upon one or more of the large veins, it may, by its mere mechanical pressure, cause such a congestion as to lead to œdema of those parts from whence the obstructed vein should remove the blood.

It is also worthy of note that in the cases of aneurism, which I have examined in the Charity Hospital, there was most generally more or less fatty degeneration of the arterial coats, in various portions of the circulatory system.

CASE 680: *Aneurism of Internal Iliac.*

Thus in the case of a large aneurism of the internal iliac, which filled the entire pelvic fossa on the left side, measuring eleven inches in the longest diameter, and six and a half inches in the short diameter, the heart is partially degenerated into fat and the entire aorta is dilated, with thickened, degenerated, roughened walls.

CASE 681: *Aneurism of Descending Aorta; Absence of Œdema; Great Emaciation; Death.*

The body of this man, aged sixty, after death, presented no marks of dropsical effusion, and was greatly emaciated. The descending aorta was dilated into a large aneurism having an hour-glass contraction in the middle. The long diameter of the aneurismal tumor was six and one-half inches and the transverse diameter four inches. The vertebral column had been eroded and absorbed upon its anterior surface, by the pressure of the tumor, and adhesions had formed between the walls of the aneurism and the diaphragm. No dropsical effusion was discovered in the areolar tissue and serous cavities after death, and none had been observed during his residence during the past three months.

CASE 682: *Aneurism of Ascending Aorta; sudden rupture of Aneurismal Sac within the Pericardium; Hæmorrhage—Death. Absence of dropsical effusion.*

A young woman entered the Charity Hospital, complaining of a pain in the region of the heart; the general health appeared to be good—complexion clear and limbs round and firm. This patient died suddenly a short time after entering the hospital. When the cavity of the thorax was opened, the pericardium was found to be filled with blood; the amount of which was about one pint. No blood was effused exterior to the pericardium, and there were no marks of dropsical effusion in any of the serous cavities, nor of œdema in any of the extremities. Death in this case appeared to have resulted from the sudden compression of the heart, by the blood effused into the pericardium, rather than from the amount of blood lost. As is well known that portion of the aorta which arises from the left ventricle, behind the sternum, opposite the third intercostal space, and passes from left to right, the ascending portion of the arch, coming to the right of the sternum, between the cartilages of the second and third ribs, is within the pericardial sac. The ascending aorta together with that portion of the arch from which the carotid, innominate and subclavian arteries are given off, was enlarged or dilated to more than twice the normal diameter, and a diverticulum or pouch from the aneurismal dilatation was sent off, downwards from the arch of the aorta, and rested against the auricle. The rupture took place at the most dependent portion of this division or diverticulum from the dilated aorta, just where it rested upon the auricle.

In the case of aneurism of the femoral artery operated on by Dr. Warren Stone, Jr. and which terminated fatally from hæmorrhage and pyæmia, I found the artery for some distance above the seat of the aneurism in a state of fatty degeneration. We can see in such a case, the cause of failure in the operation of ligation of the artery for aneurism. The ligatures cut through the softened and degenerated arterial coats, and hæmorrhage occurred; compression had been previously tried without success. It is probable that in such cases, the results of compression would be rendered unsatisfactory from the degeneration of the coats of the artery.

In the three following cases, no dropsy and no tendency to it was at any time observed.

CASE 683: *Aneurism of Arch of Aorta, involving also the Ascending Aorta; Absence of Dropsical Swelling; Death.*—Michael McCann, male, age 35 years; height 5 feet 6 inches; weight 120 pounds; dark brown hair, grey eyes, dark florid complexion, sharp features; native of Ireland; has been twenty years in New Orleans; occupation, day laborer; had syphilis ten years ago, which the patient says affected him for several months; had yellow fever fifteen years ago; and chills and fever in the summer months of 1868.

Admitted into the Charity Hospital November 14, 1868, suffering with pain in right arm, extending up along the side of the neck and head, and attended with difficulty of deglutition. Patient says that he suffered with pain in the right elbow joint, in August, 1868, which lasted three months, and then shifted to the right shoulder joint, and from thence passed to the head, with which he still suffers. Before coming to the hospital, was treated with local applications and liniments, without any perceptible benefit. For four or five weeks after entering the hospital, the patient could not lie down by day nor by night, on account of the great oppression of breathing, and a most troublesome cough, and sensation of choking, in the recumbent posture. He lost flesh, his weight being reduced from 155 in health, to 120 pounds. The treatment has consisted chiefly of anodyne, sub-cutaneous injections of Morphia and Atropia, at night; Iodide of Potassium, as an alterative, and Tincture of Sesqui-Chloride of Iron, as a tonic. The pains are relieved by the sub-cutaneous injection of Morphia and Atropia, and the patient is unable to sleep without them.

April 3d, 1869: Condition of the patient much the same as when he entered the hospital. Constant cough and constriction about the throat. The patient coughs and clears his throat in a peculiar manner, as if a tumor was pressing upon the bronchial tubes. General appearance favorable; patient is not emaciated or swollen. Skin dry and warm, tongue reddish upon surface. Suffers with pain in head, and neck, and upper part of right side of thorax. Pulse strong, but differs in character and intensity in the two arms, 70 per minute; apex beat of heart visible one inch below its natural position. Pulsation very marked and forcible over the upper portion of the sternum, producing a loud impulse against the walls of the chest, over the intercostals of the first and second ribs, immediately to the right of the sternum, where the sounds are loudest. There is also flatness, on percussion, over the infra-clavicular region, on right side of chest, where the sounds of the heart are heard with the greatest intensity. Temperature of axilla variable, ranging from 98°.5 to 100°.5 F. The respiration varies from 18 to 22, and is natural, with the exception of some prolongation of expiration and inspiration, and a peculiar sound, as if the bronchial tube was pressed by a tumor. The constant cough, and peculiar clearing of the throat, in like manner indicates the presence of a tumor pressing upon the wind-pipe. There is also difficulty and pain in deglutition.

These symptoms led to the conclusion, that this patient was suffering with an aneurism of the aorta, involving the ascending portion, the arch, and probably also the upper portion of the descending aorta.

April 6th: The heart is beating tumultuously, the apex sound being much more distinct than the sound made at the intercostals of the first and second ribs. The pulse in the right arm is weaker than in the left. When the patient raises the right arm and attempts to grasp the bed-post as high up as the arm can reach, standing with his back to the bed and throwing the hand a little backwards, as well as upwards, he experiences numbness, also a tendency to faint.

May 6th: There appears to have been a gradual change in the position of the supposed aneurismal tumor in the chest; careful and prolonged examination revealing a more tumultuous and powerful impulse against the supra-clavicular region of the left side. The subclavian artery of the left side appears to have suffered dilatation, as it is of great size, and the column of blood is thrown with great power and a marked thrill through its dilated walls, with every impulse of the left ventricle. On the other hand, it is remarkable that the carotid artery on this, the left side, can scarcely be felt, being exceedingly small in outline and feeble in beat. In fact, it is almost impossible to feel the beat of the carotid, without the most persistent and careful examination. As the carotid and sub-clavian are given off separately from the arch of the aorta, on the left side, we are forced to one of three conclusions: either the carotid on the left side has been partially occluded by fibrinous matter deposited along the walls of the aneurism, or the tumor presses upon it in some manner, so as to diminish its column of blood, or the aneurism does not extend much beyond the junction of the left subclavian. The third supposition is excluded by the previous history of the case. It would appear that this tumor was slowly shifting its position to the left of the vertebral column. It is well known that the soft parts become incorporated with the aneurismal tumor, and even the vertebræ are absorbed by the constant pressure, as was seen in the case of the aneurism of the descending aorta, previously described. The diagnosis of aneurism of the arch of the aorta, appears by these signs, and especially by the movable nature of the tumor, to be still further confirmed.

May 30th: Under nutritious diet, and moderate purgation, and the persistent use of Iodide of Potassium, alternating with the Tincture of the Sesqui-Chloride of Iron, the condition of this patient has somewhat improved; at least he has certainly "held his own."

Patient does not suffer any pain of consequence; heart is not so forcible in its action; the left radial pulse is still stronger than the right, whilst the beat of the right carotid is much more powerful than that of the left, which can scarcely be felt. Dullness upon percussion, with bronchophony extending from the left border of the sternum, to the middle of right clavicle, thence downwards, to midway between clavicle and nipple, thence inwards to left border of sternum, thence upwards to starting point, making an area of marked dullness and bronchophony, of about four inches in diameter.

June 9th: Patient is suffering more than usual pain in head; and neck and supra-clavicular spaces have a full, swollen appearance. The patient also suffers pain in the middle and upper portions of the thorax, in the region of the aneurismal tumor; he complains of a smothering sensation in the throat.

June 21st: Condition of the patient good; complexion that of health; appetite good. Impulse of heart quick and powerful, two and a half inches below left nipple. The apex of the heart acts as if it was thrust directly forwards against the walls of the thorax, making a defined beat. The beat of the heart gives the impression of a tumor above, which forces the heart downwards, or rather, from which the organ recoils.

Left supra-clavicular region prominent, a powerful pulsation synchronous with the contraction of ventricles of heart being evident to the eye, and also to the touch, above the middle of the clavicle. Left carotid artery can scarcely be felt in its beat. The first sound of the heart is heard at the apex, mingling with the powerful blow against the walls of the thorax; the second sound is not distinct, and there appears to be a third sound, which may be due to the pulsation of the aneurism, together with some clicking, thrilling, rushing sounds of low intensity. Marked dullness in both supra-clavicular regions along the borders of the sternum, and over the sternum, for two inches below the nipple. Distinct metallic click or thrill over upper portion of sternum.

The air is drawn in and expelled from the bronchial tubes with difficulty, as if the windpipe was compressed. Difficulty of deglutition continues, solid food appears to be arrested about midway in the œsophagus, or rather, at the upper third of the sternum.

This patient continued under my treatment until the first of November, 1869, when a change occurred in the wards, and he passed into the hands of Professor Bemiss. Up to this time, the patient had maintained apparently a stationary position; the most marked symptoms for the worse was the stridulous breathing and sense of suffocation.

The patient continued much in the same condition, with a gradual aggravation of the disturbance of respiration, and finally died on the 10th of April, 1870. We are informed by Professor Bemiss that up to the time of death there was no dropsical effusion.

A post-mortem examination was held by Dr. Bemiss, and he kindly presented the heart and aneurismal tumor to my pathological collection.

The heart was enlarged, and dilated, and fatty, degenerated, and flabby. All the cavities were dilated, but the dilatation was greatest in the left ventricle. The arch of the aorta was dilated into a large aneurismal tumor, thirteen inches in circumference, and contained a large laminated fibrinous mass, eleven and a half inches in circumference. Portions of this fibrinous clot were evidently of recent formation, and contained coagulated blood. The ascending aorta was greatly dilated, the dilatation commencing at the junction of the aorta with the heart, and gradually increased upwards to the aneurismal tumor. The diameter of the ascending aorta, just before it passes out of the pericardium, was three inches. The pericardium was thickened. The semilunar valves of the aorta, as well as those of the pulmonary artery, and the tricuspid and semilunar valves, appeared to be normal in structure.

The result of the post-mortem confirmed the diagnosis twelve months before death, viz: Aneurism of arch of aorta.

The wind-pipe was compressed into a flattened, ribbon-like tube, and the mucous membrane presented a thickened and highly congested appearance. The aneurismal tumor pressed upon the lower portion of the wind-pipe and upon the bifurcation of the bronchial tubes.

CASE 684: *Aneurism of Arch of Aorta; Great Oppression of Respiration; Absence of Dropsical Swelling; Death.*—William Willoughby, aged 36; height 5 feet 3 inches; weight 147 in health; auburn hair, gray eyes, fair complexion; native of Canada; seaman by occupation. At eleven years of age suffered with chills and fever, which continued seven years; had yellow fever in 1858; had two falls on ship-board, when intoxicated; these falls were from considerable heights, but no ill effects were noticed. About five months before entering the hospital, was in the habit of using his shoulders in pressing up heavy weights, and after straining, felt pains in the region of the heart; about a month afterwards began to suffer with pains across the thorax, in right arm, and on side of neck and face.

Admitted to Charity Hospital, February 3d, 1869, suffering with pains in the thorax, right arm, and in side of neck and face, and after remaining in ward 21 for one month, a tumor or swelling, with a livid surface appeared, extending from four to six inches across the thorax, in a line with the second rib; this remained for several days, and then slowly subsided. At the time of his admission, the patient weighed only 125 pounds. He suffered with great oppression and difficulty of breathing, and was unable to sleep at night in the recumbent posture. The treatment consisted of sub-cutaneous injections of Sulphate of M[illegible]d Atropia. Rest at night could be procured only by these injections. The e[illegible]

Atropia were almost immediately manifest, in the rapid dilatation of the pupils of both eyes.

April 1st: The patient came under my treatment and observation at this time. Says that he does not suffer so much pain. General appearance that of health, with clear, florid complexion; no œdema or dropsical effusion in any part of the body; his countenance, however, wears an anxious, and, at times, distressed and oppressed look; weight 125 pounds, appetite fair; bowels regular; skin soft and natural; tongue clean; pulse 88; suffers with cough and oppression in breathing. Apex of heart displaced, two inches below, and to the left of the nipple; action of heart strong; pulsations very marked over the sternum, and visible at the apex. Great difficulty in the deglutition of solid food, from the pressure of the aneurismal tumor upon the œsophagus, with a sensation as if the passage of the food was interrupted about the centre of the sternum. Respiration 19 per minute and embarrassed, with cough when lying upon back. The cough and clearing of the throat is peculiar in its character, giving the impression of great constriction of the wind-pipe and the bronchial tubes, and the sounds are heard as if they proceeded directly from the upper third of the sternum. Pulse feebler in the right, than in the left arm.

Diagnosis.—Aneurism of Arch of Aorta.

May 12th: Complains of pain in side of neck and head, and over the sternum; difficulty in respiration very marked, and amounting to decided dyspnœa, especially when attempting to assume the erect position. The least particle of phlegm in the trachea, gives much trouble and distress until removed. Clears his throat in a peculiar manner, as if the bronchial tubes were compressed. Great difficulty in the deglutition of food.

Impulse not so marked over sternum, as if the tumor was imbedding itself in the posterior walls of the thorax, and against the vertebral column.

May 25th: Pain not so great, but general appearance less favorable. Hypodermic injection of Morphine and Atropia administered last evening, and the patient is this morning in a nervous state; pulse 96; temperature of axilla 101°.75; pulse in right arm very indistinct.

May 31st: Bronchial rales over both lungs; rales and vocal resonance more marked over right lung; these physical signs appeared to be clearly referable to the pressure of the aneurismal tumor upon the trachea and bronchial tubes.

The sternum appears to be more prominent upon the right side; apex of heart still further displaced to left of nipple; sounds at this point apparently normal, though with less force than before, and the sound heard over the base, viz: the second.

The bronchial rales are unattended with much expectoration, and it appears as if the mucus is with great difficulty expectorated through the compressed bronchial tubes.

June 10th: Symptoms greatly aggravated; great difficulty of deglutition; great oppression in breathing, with prolonged, wheezing inspiration and expiration, as if the air passed through the compressed bronchial tubes and trachea with great difficulty. The patient, although oppressed, distressed and weak, still moves about the ward and hospital.

When the ear is placed against the walls of the chest, the sounds of the voice and of respiration appear to issue directly out over the space of at least five inches in diameter, as if the sonorous vibrations were transmitted directly through a tumor. Percussion revealed dullness over the sternum, and over the greater portion of the clavicular and infra-clavicular spaces. The form of a tumor and its position, may be made out with great clearness, by combining percussion and auscultation. The diagnosis is especially aided by causing the patient to speak when the ear is applied to different portions of the thorax. The position of the tumor may be made out by auscultation and percussion on the back, as well as upon the front of the chest.

When the patient coughs, the sounds are transmitted, almost like peals of distant thunder, to the ear applied over the walls of the chest just above the tumor. The loud bronchial *rales*, heard most distinctly over all the upper portion of the lungs, appeared to be due solely to the pressure exerted by the tumor.

The patient is evidently near his end, and at this examination the opinion was expressed that his life would terminate suddenly from suffocation in the course of a few days.

During the night of the 13th of June, the patient was seized with great difficulty of respiration, became black in the face, struggled violently for breath, and died suddenly from the effects of the compression of the bronchial tubes, or arrest of respiration.

This patient had friends, who carried off his body before a post-mortem examination could be made. This was greatly to be regretted.

It was clearly shown in the preceding cases also, that the most extensive aneurisms are not necessarily attended with dropsy.

CASE 685: *Aneurism of Ascending Aorta and Arch of Aorta; Dilatation of left Ventricle; Sudden Death; Absence of Dropsical Effusion or Œdema.*—Mooney, age 56, native of Ireland, tall, well formed man, entered the Charity Hospital, ward 16, bed 150, January 16th, 1870. Has been in this hospital several times before.

At the time of my examination, January 18th, the patient presented well developed limbs. Suffered with great oppression in breathing, loss of rest, and almost complete prostration after making any effort. I attempted to examine this patient, but he suddenly became greatly oppressed, his lips and hands turned blue, and the patient appeared to be dying.

The results of this imperfect examination, were dullness upon percussion, over and around the space normally occupied by the heart, for an area, the diameter of which was at least seven inches transversely, and eight inches laterally; the apex beat of the heart was at least two inches below its normal position; great oppression in breathing, inspiration and expiration prolonged, with a wheezing sound, as if the air was passing through a greatly constricted trachea. It was necessary to prop the patient up in the sitting posture before an open window. The symptoms of enlargement of the heart and aneurism of the aorta were well marked. This patient died suddenly next morning.

The post-mortem was performed eight hours after death.

The exterior was full and without marks of œdema.

When the cavity of the chest was opened, the heart was found to be enlarged, with all the cavities distended to their utmost capacity with dark fluid blood. The ascending aorta was greatly dilated, the dilatation commencing at the heart, and increasing rapidly upwards, and just after emerging from the pericardium, the arch of the aorta expanded into a large aneurismal sac, six inches in diameter. The arteries given off from the arch of the aorta were greatly dilated, and the innonimate artery, was, at its junction with the aneurismal tumor, as large as a healthy aorta. The pericardium was adherent to the heart, this adhesion appeared to have been of long standing, and was probably coincident with the changes in the semilunar valves. The heart measured in its longest diameter, seven inches, and in its short diameter, six inches. The semilunar valves of the aorta were thickened, adherent at certain points and insufficient. The aortic regurgitation accounts for the great dilatation of the left ventricle. As far as we could learn, this patient had suffered with deranged action of the heart and oppression of breathing for more than six months, and he referred the first distressing symptoms, to the lifting of a great weight.

We shall consider in the next place, briefly the treatment of cardiac dropsy.

TREATMENT OF CARDIAC DROPSY.

When dropsy depends upon serious organic lesions of the heart and large blood-vessels, treatment should be regarded as chiefly palliative; the physician may relieve certain symptoms of the most grave and distressing character, and relieve intense suffering and thus prolong life, for a considerable length of time; but the cure of the disease, is in many cases out of the question, as it is impossible either by drugs, diet or mechanical means to restore the enlarged, dilated, degenerated heart and insufficient valves, to the normal state.

Cardiac dropsy supervenes in most cases, after the forces have been depressed, and the blood rendered watery; venesection therefore as well as drastic purgatives should be used with great caution. Local blood-letting (cut cups over the region of the heart and kidneys) may accomplish good results by relieving congestion and promoting free diuresis.

It is well known that diminished fullness of the vascular system promotes the absorption of serous effusions; when therefore obstruction to the circulation of the blood through the heart, co-exists with pulmonary congestion and anasarca, and at the same time, the general vigor is as yet unimpaired, the abstraction of a moderate quantity of blood, affords relief to the over-loaded blood-vessels, and congested lungs, and facilitates the action of hydragogue remedies.

Bitartrate of Potassa, the Compound Jalap Powder, Gamboge and Elaterium, are peculiarly valuable, from their certainty of action as hydragogue purgatives.

From one ounce to one ounce and a half of the bitartrate of potassa, in eight ounces of water, taken in two doses, at an interval of two or three hours, forms one of the most effective and safe purgatives.

The extract of Elaterium may be administered in doses of from one-sixth to one-half of a grain. Caution, however, must be employed in the use of the Extract of [illegible] rium, on account of its intense activity, and occasionally depressing effects. A bolus of the following composition has been recommended and employed with success by various physicians: ℞. *Pulveris Jalapæ*, *Pulveris* Rhei., Pulveris Scammonii āā, gr. v; Elaterii, gr. ss; Bitartratis Potassæ; Sulphatis Potassæ, āā, ʒss; Syrupi Zingeberis; *quantum sufficet ut fiat bolus.* It is an observation of long standing, that in the exhibition of remedies, more decided and beneficial effects may be obtained by combining several analogous remedies in small quantities, than by giving a single one in a large dose.

In cardiac as in other forms of dropsy, the urine is almost always scanty, and the progress of the effusion frequently bears a direct relation to its diminution; the attention therefore should be strongly directed to the secretory function of the kidneys, as affording the most probable channel for the relief of the disease.

Although sometimes uncertain in their action, diuretics upon the whole prove most effective in the control, moderation and even complete removal of dropsical effusions.

As far as my experience extends, the Bitartrate of Potassa or Cream of Tartar, is the best diuretic, and I have relieved many cases of dropsy by this remedy alone. When used as a diuretic, from half an ounce to one ounce and a half should be suspended in a pint of water, and the mixture should be taken in wineglassful doses every two or three hours so that the whole may be administered during the twenty-four hours. The bottle containing the mixture should be always most carefully agitated, as the cream of tartar is almost insoluble, and falls to the bottom of the vessel upon standing. When the digestion is impaired, or should dyspeptic symptoms be induced by the cream of tartar, we should employ as a vehicle for the salt, an infusion of juniper berries or wild carrot seed, and some aromatic, cardamom, fennel or ginger may be added.

It would be foreign to our purpose to enter into any recapitulation of the observations made at the bedside with reference to the various diuretics, and we shall simply name those of the most undoubted efficiency; such as:

Acetate, Nitrate and Citrate of Potassa; Acetate of Ammonia; Iodide and Bromide of Potassium; Nitric Ether; Squills; Digitalis; Veratrum; Colchicum; Tobacco; decoction of Scoparium and of Chimaphila.

Squill as an active diuretic has enjoyed a high reputation with the profession, and it appears to be peculiarly useful in dropsy of the chest, with scanty high colored and uncoagulable urine, which deposits a sediment on standing. It should be used at short intervals and in such doses as to produce nausea, and the patient should be subsequently kept just within the nauseating point. In cases which demand the mercurial influence, the squill may be advantageously combined with calomel. Small doses of Blue Pill, occasionally at bed time, will frequently promote the action of diuretics.

Diaphoretics are much less efficient than diuretics, and cathartics; beneficial results, however, may be obtained by the free diuresis excited by the vapor or hot air bath.

When drugs fail to control the dropsy, mechanical means become necessary for controlling its influence; such as tapping, puncture with a sharp lancet and acupuncture. Owing to the danger of the supervention of erysipelas, incisions should be made with great caution, and whenever practicable, puncturing with the needle should be preferred, the point of the needle should merely penetrate the true skin, the punctures should vary in number from twenty to fifty or sixty, according to the part or the extent of the effusion, and they should be at least half an inch asunder.

When the blood is anæmic, Iron and the bitter tonics, and nutritious diet should be employed.

Experience has established the fact, that no advantage arises from the denial of water to dropsical patients.

In some cases attended with great debility, spirituous liquors, in moderate amount, are indicated; hard cider and gin, are amongst the best forms of alcoholic stimulants.

Of course, the results of treatment will depend, in a great measure, upon the extent and character of the organic lesions.

CHAPTER XIV.

HEPATIC DROPSY, ARISING FROM SOME OBSTRUCTION TO THE CIRCULATION OF THE BLOOD THROUGH THE LIVER. CIRRHOSIS, FATTY DEGENERATION, AND ATROPHY OF THE LIVER.
DROPSY RESULTING FROM OBSTRUCTION OF THE PORTAL CIRCULATION IN CIRRHOSIS OF THE LIVER.
DROPSY RESULTING FROM CIRRHOSIS OF THE LIVER AND CARDIAC DISEASE.
TREATMENT OF HEPATIC DROPSY.

HEPATIC DROPSY, ARISING FROM SOME OBSTRUCTION TO THE CIRCULATION OF THE BLOOD THROUGH THE LIVER.

The distinguishing characters of dropsy, from diseases of the liver or portal vein, as laid down by systematic writers, are:

1st. In uncomplicated portal obstruction, the dropsy commences in the abdomen, and the legs are only affected secondarily and in consequence of the pressure of the ascitic fluid on the inferior vena cava. When the affection of the liver is complicated, with heart disease, the ascites may be preceded by dropsy of the legs.

In cardiac disease, on the other hand, anasarca commencing in the feet and gradually proceeding upwards, precedes the ascites; and even when the belly becomes swollen, the swelling of the legs is out of all proportion to the ascites.

2d. No signs of dropsy in the face, arms, or upper part of the trunk, are observed in dropsy arising from obstruction of the portal system; whilst in that form of the disease which is dependent upon structural alterations of the kidneys, œdema of the face and arms is a very common symptom even in the early stages.

3d. Dyspnœa, never precedes the hepatic dropsy, although it may accompany the serous effusion when great; from the pressure of the fluid interfering with the action of the diaphragm and abdominal muscles; in cardiac dropsy, on the other hand, the dyspnœa *precedes* the ascites, and is distressing out of all proportion to its extent. In cardiac dropsy, from the congestion of the lungs and imperfect aeration and circulation of the blood, there is more or less lividity of the lips, face and extremities, whilst this symptom is not characteristic of uncomplicated portal obstruction.

4th. If there be no concurrent disease of the kidneys, albumen is absent from the urine, except in those cases, in which the ascites itself, when extensive, may, in consequence of the pressure of the fluid on the renal vein, lead to the appearance of albumen in the urine. The albumen, however, disappears upon the withdrawal of the pressure, as in the operation of paracentesis. The absence of puffiness of the face, or pitting of the upper extremities, and of granular, fibrinous, and oil casts from the urine, will still further distinguish hepatic dropsy, from that dependent upon alteration and degeneration of the kidneys.

5th. The ascites occasioned by portal constriction, is still further distinguished, by enlargement of the spleen, enlargement of and tortuosity of the superficial veins of the abdomen, hæmorrhoids, gastro-enteritis and hæmorrhages from the stomach and bowels. Enlargement of the superficial veins of the abdomen, however, is not in all cases a certain indication, as the same appearance is sometimes observed in cardiac dropsy and in renal dropsy, as the result of the pressure of a large quantity of ascitic fluid upon the inferior vena cava; but in such cases, there will be usually also a varicose state of the veins of the legs.

It is important that we should consider briefly those morbid conditions of the liver, which give rise to dropsical effusions, in connection with those diseased states of this organ, which seldom or never gives rise to this symptom.

In waxy, lardaceous or amyloid degeneration, the liver undergoes greater enlargement than in any other disease, excepting perhaps, cancer; the enlargement being often so great as to fill up a large portion of the abdominal cavity. The enlargement being uniform in every direction, the form of the organ is not essentially altered, the outer surface is smooth, and the lower margin more rounded than natural, regular and free from all indentations. In rare cases, this change may co-exist with cirrhosis, or with syphilitic gummy tumors, and then the organ may present a nodulated surface, and this complication may be attended with ascites.

In like manner when accompanied with waxy degeneration of the kidneys, dropsy may result from the derangement of the excretory function of these organs.

In those cases of waxy deposit of the liver, which have come under the observation of the students of the Medical Department of the University of Louisiana, the statement of pathologists has been verified, that there is but little tendency to obstruction of the portal circulation; and consequently ascites, and enlargement of the subcutaneous veins of the abdominal walls, are not common phenomena in its clinical history. The absence of ascites in waxy liver, has been accounted for by the fact, that the branches of the hepatic artery, and not of the portal vein, are implicated in the disease. In some rare cases of waxy liver, ascites results from the pressure of enlarged waxy lymphatic glands in the fissure of the liver, upon the trunk of the portal vein.

In fatty liver, the enlargement is due to the accumulation of oil, as has been well shown in the post-mortem examinations, and in the specimens of fatty liver mounted in alcohol. In fatty liver, as in the waxy disease, the enlargement is uniform in every direction, and without tumors or nodules upon the surface, and the natural form of the liver is but little altered; there is no ascites or enlargement of the superficial veins of the abdomen, the secretion of bile is not arrested or impeded, and jaundice is not a symptom, and as in waxy liver, throughout the progress of the disease, pain is absent. This degeneration of the liver is often accompanied by similar changes in other organs, and more especially the heart and kidneys. Fatty degeneration of the heart is evidenced by the feeble cardiac impulse, faint cardiac sounds, slow or quick, feeble and irregular radial pulse, attacks of vertigo, syncope or pseudo-apoplexy, and dyspnœa on slight exertion. When fatty degeneration of the liver, is attended by fatty degeneration of the kidney, there will be a tendency to general anasarca; the urine is diminished in quantity, oftimes turbid, and contains albumen and casts of the tubuli uriniferi, containing oil globules.

In simple hypertrophy of the liver, attended by an increased size of the lobules, and by an increased size or number of the secreting cells, without any alteration of structure, the enlargement is uniform, and rarely great, and is not attended by any prominent symptoms nor by dropsical effusion.

Whilst the enlargement may be very great in hydatid tumor of the liver, ascites, œdema of the lower extremities, enlargement of superficial veins of the abdomen, and hæmorrhoids are not distinguishing characters; and as the hydatid tumor rarely interferes with the functions of the kidneys, those of the urine so common in waxy and fatty enlargements, are absent; in rare cases, however, the kidneys also may be the seat of hydatids, and dropsy may arise from this cause, or from the pressure of the hydatid tumors upon the portal trunk; or from the bursting of the cyst, or through the supervention of peritonitis.

Ascites rarely results from mere congestion of the liver, unless this depend on mechanical obstruction of the circulation in the heart and lungs.

In the venous engorgement of the liver resulting from mechanical obstruction of the cardiac circulation from valvular disease of the heart, the primary enlargement of the liver gives place after a time to an opposite condition of contraction, atrophy of the *central portion of the lobules*, being induced by the pressure of the constantly distended veins. The congestion of the liver dependent upon cardiac disease, induces a form of granular liver very different from true cirrhosis, where the atrophy commences at the *circumference of the lobules.*

The diseases of the liver which most commonly give rise to portal obstruction, with ascites, are, according to those pathologists who have had the most extensive opportunities of observation: 1. Cirrhosis and other forms of chronic atrophy of the liver; 2, cancer of the liver; 3, peri-hepatitis; 4, thrombosis, or obstruction of the trunk of the portal vein.

We shall confine our observations to the first and most common cause of portal obstruction and ascites; viz: cirrhosis of the liver.

Cirrhosis of the liver is most common in those countries, where the drinking of alcoholic stimulants prevails, and the disease can almost always be traced to the abuse of strong spirits; and hence the name *gin drinker's liver.*

Most observers have noted in the early stages of true cirrhosis, a temporary congestion and enlargement of the liver, apparently caused by the irritant effects of the alcoholic stimulants.

The lobules of the liver have been described by Malpighi, Kiernan, Müller, Leidy, and others, as isolated from each other, and each invested with a layer of areolar or fibrous tissue. In the pig, in which these lobules were first noticed, and in the Polar bear according to Müller, and in the Octodon Cummingii, according to Hyrtl, the lobules are invested by fibrous tissue, but in the liver of the human subject, and in that of the vetebrate animals generally, the lobules are not separated from each other by a fibrous partition, and there is no areolar or fibrous tissue or prolongation of Glisson's capsule between them or in their interior. Vogel, Henle, Bowman, and Beale have failed to detect any fibrous tissue in the interlobular fissures of the normal human liver.

In cirrhosis of the liver, on the other hand, there is a remarkable development of fibrous tissue in the parenchyma of the liver; and the individual, secreting segments become prominent or even form isolated lobules. The increase of fibrous tissue in the cirrhosed liver, may be manifest to the eye, and especially when slices of the organ are subjected to the action of a stream of water, and gently mashed between the fingers. The character of the fibrous tissue may be determined by microscopical examination. Cirrhosis of the liver is of slow development and progress. The whole structure of the liver is not pervaded with fibrous tissue in a few days. It is reasonable to conclude with Dr. Budd, that the remarkable changes in cirrhosis, are mainly the consequence of adhesive inflammation in the areolar tissue about the small twigs of the portal vein, and in the areolar tissue of the portal canals, by which serous fluid and coagulable lymph are poured out.

In this stage the liver may be enlarged. The serous part of the effusion is next absorbed, the lymph contracts, becomes converted into dense fibrous tissue, which divides the lobular substance of the liver into well defined masses, and gives great density and toughness to the organ. Finally, this fibrous tissue compresses the small twigs of the portal vein and the small gall ducts, and thus impeding the escape of the bile, and the flow of blood induces great atrophy of the original hepatic tissue, and causes by a deprivation of the blood and the admixture of this dirty white fibrous tissue, marked changes in the color of the liver.

In cirrhosis, the normal, dull, reddish brown color of the liver is altered to a bright canary yellow, sometimes to a brownish or greenish, and occasionally to a reddish color. A section of the liver, upon a general view, presents the grayish and yellow color of impure beeswax.

Owing to the contraction of the organ in the latter stages, the outer surface presents a granular or nodulated character, which has given rise to the designation, "*hob nail liver.*" The yellow color of the organ is also due to the large amount of yellow pigment contained in the secreting cells, and hence the term cirrhosis. The capsule is also sometimes thickened and adherent to the surrounding parts.

In the firm, tenaceous, granular liver, resulting from the congestion caused by obstructed cardiac circulation, and which has frequently been mistaken for cirrhosis, the depressions, however, correspond to the centre of the lobules, whereas, in true cirrhosis, they are at the circumference.

Ascites, resulting from portal obstruction, is met with oftener in cirrhosis than in any other disease of the liver. The fluid in the peritoneum, is a clear yellow, serum, rich in albumen, and without any blood or inflammatory products. In consequence of the congestion and distention of the veins that return the blood from the intestines and peritoneum, the serous portion of the blood transudes through the walls of the vessels into the peritoneal cavity, and when once ascites appears, it persists and gradually increases; and when the amount of the effused fluid is large, it may compress the inferior vena cava and iliac veins, and thus produce secondary œdema of the legs, but it is a peculiarity of dropsy from uncomplicated portal obstruction, that the ascites precedes and preponderates over dropsy elsewhere. A large accumulation of fluid in the peritoneum may also interfere with the action of the diaphragm, and cause embarrassment of respiration, but it is distinguished from the ascites caused by cardiac disease, by the fact that the *dyspnœa follows and never precedes the ascites.* Pressure exerted on the renal veins by a large quantity of fluid in the peritoneum, may also embarrass the action of the kindeys, and lead to the appearance of albumen in the urine, independently of any disease of those organs, the albumen disappearing from the urine, after the removal of the pressure by the operation of paracentisis.

The following cases will illustrate the characters of dropsy resulting from portal obstruction:

CASE 686: *Dropsy resulting from obstruction of the portal circulation in Cirrhosis of the Liver.*—This case illustrates in a striking manner, the effects of obstruction of the portal circulation, in the production of ascites, and of serous effusion into the cellular tissue of the lower extremities.

S. McL——, native of Rapides Parish, Louisiana; lately a resident of Catahoula Parish; has been engaged in farming during the past two years; age 35; height six feet; blue eyes, dark hair, dark complexion, thin beard; no heriditary tendencies; up to the present attack has enjoyed good health with the exception of occasional attacks of chills and fever. Patient says that he has used ardent spirits in moderation, and never to excess, except upon one occasion when he had an index finget shot off.

Patient states that three months since, was seized with violent abdominal pains, extending from the umbilicus to the pubis, and attended with griping. A few days afterwards was seized with violent vomiting and ejected a large quantity of blood ("an ordinary blue bucket full";) the vomiting and loss of blood was attended with great exhaustion; four days afterwards, there was a repetition of this attack, attended with vomiting of blood.

Two weeks afterwards an increase in the size of the abdomen was observed, attended with swelling of the lower extremities. Purgatives and diuretics were administered; the patient remembers that Eleterium was used which appeared to be productive of no beneficial effects. Three weeks since his lower extremities began to ulcerate, and the ulcerations involved the subcutaneous areola tissue, and ragged indolent ulcers appeared.

This patient was admitted into the Charity Hospital, ward 19, bed 284, on the 13th of April 1869, in an exhausted, restless state; abdomen greatly distended; lower extremities œdematous and ulcerated. Auscultation and percussion revealed no disease of the heart and lungs.

The lungs and diaphragm were forced upwards by the effusion in the cavity of the abdomen, the heart also appeared to be pressed upwards and forwards.

The sounds of the heart were unusually distinct and abrupt, and sharply defined, but no enlargement. dilatation, degeneration or valvular disease could be discovered. The lungs were resonant; the respiration was more frequent than usual, from the abdominal pressure, but there were no signs of obstruction in the pulmonary circulation; no pleuritic effusion, and no tubercular deposit.

The abdomen was enormously distended with dropsical effusion, and the veins of the abdominal parieties were enlarged and filled with dark blood, and presented a distinct arborescent appearance upon the abdominal parites. The lower extremities were greatly swollen, and the legs ulcerated, with thickened, indurated discolored integument. The general complexion was sallow and anæmic. The urine was scant, high-colored, and loaded with biliary acids. The swelling was circumscribed by the superior wall of the abdominal cavity, and in fact, by the diaphragm. All above this was of the normal appearance, and the face, and arms, and thorax, were thin and wasted, almost skeleton-like, whilst all below the diaphragm was swollen and infiltrated with serous fluid.

The sallow, jaundiced hue; the presence of the constituents of bile in the urine; the limitation of the swelling to the abdominal cavity and lower extremities; the absence of all organic disease of the heart and lungs; the absence of albumen and of fibrinous casts from the urine; the abdominal dropsy, and the congestion of the venous system of the abdomen and lower extremities, all sustained the diagnosis, that this was a case of CIRRHOSIS OF THE LIVER, *in the latter stage of contraction, unattended by disease of the heart, lungs or kidneys.*

The bowels were opened with two Compound Cathartic Pills, and the patient was placed upon the diuretic mixture composed of Cream of Tartar oz. i, Juniper Berry Tea (Juniper Berries oz. 1, boiling water f. oz. xvi; after cooling strain) f. oz. xvi; to be taken in wineglassful doses during the twenty-four hours.

April 15th—Temperature of axilla, 97°; it is of importance to note that the temperature is below rather than above the normal point. This depression appears to be due to the obstruction, in the portal circulation, caused by the cirrhosis and contraction of the liver, and also to the interference of the circulation and respiration from the abdominal pressure.

This observation, as well as others, confirmed the accuracy of the diagnosis, as to the absence of tuberculosis, and also confirmed the view that the affection of the liver was of long standing, and in the stage of contraction.

Only eight ounces of urine were collected during the twenty-four hours; specific gravity 1030; high colored, loaded with biliary acids; upon standing let fall a copious deposit of urates, which disappeared when the urine was heated, and yielded a large crop of crystals (lozenge-shaped) of uric acid.

The diminution in the amount of urine appears to be due in a manner to the pressure of the fluid distending the abdomen, and also to the small amount of nourishment taken, the anæmic state of the blood, and the depletion of the serous or albuminoid elements of the blood.

April 16th.—During the night the patient was aroused about 1 o'clock A. M., with violent retching and vomiting, and ejected a greenish black matter in sufficient amount to fill an ordinary wash basin. This afforded some relief, but the patient was considerably depressed. In two hours the nausea returned, and the patient vomited a similar amount. The matter was so disagreeable in its odor, that vomiting was excited in his nurse while removing the matter from the ward.

Twenty-two ounces of urine were collected. Specific gravity, 1030, high colored; bowels free. Appetite poor.

April 17th.—The nausea, with occasional efforts at vomiting, continuing, the Bitartrate of Potassa and Infusion of Juniper Berries were discontinued. No appetite. Bowels free. Seven and a half fluidounces of urine collected; high colored and loaded with biliary acids and urates. Ulcerations of the lower extremities improving under the use of Carbolic Acid ointment. Patient restless and unhappy. It has been necessary to administer Morphine each evening to produce rest. Tincture of Cinchona, of Gentian, and of Rhubarb, in proportion of two parts of the former to one of the latter, have been given, properly diluted, in wineglassful doses, as a tonic and gentle laxative.

April 18th.—Symptoms the same; the distention of the abdomen has progressively increased. Only four fluidounces of urine collected during twenty-four hours.

April 19th.—No change; distention of the abdomen so great as to embarrass in the most distressing manner the action of the heart and lungs.

It was determined to tap the patient upon the following morning. Sixteen and a half ounces of urine were collected; upon careful testing no albumen was discovered; urine high colored and loaded with urates and biliary acids; specific gravity, 1030.

April 20th.—Operation of paracentisis performed midway between the anterior superior spinous process of ilium and umbilicus; three and a half gallons of serous fluid were drawn off, which presented a light golden yellow color. Specific gravity of serous fluid 1009, and upon the application of heat, the coagulated albumen filled about one-fifth of the test-tube. The patient expressed great relief. Percussion revealed no enlargement of the liver, but an actual diminution in the volume of this organ. After the application of the bandage around the abdomen, the patient was put on stimulants and nutritious diet.

Seventeen ounces of urine collected, high colored, loaded with urates and biliary acids; free from albumen; specific gravity 1027.

April 21st.—Condition of the patient apparently improved by the tapping; appetite good; swelling rapidly subsiding from the lower extremities, and ulcers healing. Twenty-four fluidounces of urine collected; high colored; specific gravity 1027; no albumen.

April 22d.—Patient perspiring freely; previously the skin had been dry and harsh. Serous fluid gradually accumulating in the abdomen. Appetite good, spirits cheerful, bowels regular. Urine presented similar character.

The patient was placed upon a gentle course of mercury, one grain every four hours and on the 27th his gums were slightly touched; the abdominal swelling, however, went on steadily increasing. The patient continued to lose strength, and the accumulation of serous fluid in the abdominal cavity continued until the distention was as great as before the first tapping, bedsores began to form on the 29th, and a persistent diarrhœa set in, which was not arrested by astringents.

The patient became delirious on the night of the 30th, and lay in a semi-comatose state, and passed his urine and excrements in bed; and gradually sank by almost imperceptible stages, lying for two days in a state which could with difficulty be distinguished from actual death, and finally died at 4 o'clock, P. M., May 3d.

The *post-mortem* performed twelve hours after death, revealed the following points:

Upper extremities, head, neck and thorax, greatly emaciated, merely the skeleton with the skin stretched over; abdominal cavity and lower extremities greatly swollen and distended. The abdominal cavity contained near four gallons of serous fluid.

The lungs were healthy; without tubercles, or adhesions, or any marks of inflammatory change.

The heart was normal in size, with no lesions of the valves; the pericardium, however, was adherent, and this adhesion of the serous membrane of the heart, throughout its entire extent, accounted for the more distinct sounds of the heart.

The liver was greatly contracted, hardened, and of a slate color; and the spleen also was enlarged and hardened, and of a similar color with the liver. The kidneys were congested but healthy. No derangement beyond congestion of the blood-vessels was discovered in the kidneys.

The liver was cirrhosed, hardened and greatly diminished in size; the weight being only twenty-four ounces; the length ten inches, and breadth four and a half inches, and greatest thickness two and a half inches. The liver had lost the appearance of divisions into lobules upon the exterior, and resèmbled an elongated flattened spleen.

The color of the liver was slate on the exterior, and a mottled olive green yellow and bronze within.

The peculiar color of the liver appeared to be the result of the previous attacks of malarial fever, and the slow action of the malarial poison. Under the microscope, the fibrous tissue was found to be greatly increased, and the dark masses of altered hæmatin were scattered throughout the structures, giving to the organ, its peculiar malarial hue. The liver cut like leather and was firm and hard.

The spleen was enlarged and indurated and had lost the natural splenic mud Weight of spleen; nine ounces; length, six inches; breadth, three and a half inches; thickness, one inch. Spleen cirrhosed like the liver, and cut like leather. Contained numerous masses of hæmatin and altered blood corpuscles.

This then was a case of undoubted induration and contraction of the liver, unaccompanied by disease of the heart or kidneys; but attended with the marks of pre-existing malarial disease.

The relations of the action of the malarial poison, to the induration and contraction of the liver, are of the most important character, and demand further investigation.

The question is, whether the effects of the malarial poison were merely concurrent with, or subsequent to, the establishment of the cirrhosis, or whether they caused the peculiar state which lead to the throwing out of the fibrous matter, and the subsequent contraction and induration of the organ.

This case resembles the chronic atrophy of Frerichs, or the red atrophy of Rokitansky, in which there is no nodulation or granulation of the outer surface, and not necessarily any thickening or adhesions of the capsule. The liver affected with the chronic atrophy of Frerichs, like that of the case now under consideration, presents a dark-brown, or bluish-red color, firm consistence and homogeneous appearance, with little or no indication of a division into lobules; the secreting cells being smaller than natural and loaded with dark-brown pigment granules. In like manner, the atrophy of the organ is general, and as in the present case it has been known to weigh only twenty-four ounces. But the most important anatomical character of chronic atrophy, is said to be, the destruction of the ramifications of the portal vein, the branches of which terminate in club-shaped extremities, so that the organ cannot be minutely injected from the portal vein.

Pathologists describe this comparatively rare form of liver disease, as being occasionally seen in connection with simple and cancerous ulcerations of the stomach and intestines, or with a deposit of blood pigment in the minute vessels of the liver, in the bodies of persons, who have suffered long or often from intermittent or remittent fevers.

It is well known that both the liver and spleen are congested during the cold stages of intermittent and remittent fever, and during the action of the malarial poison, either in its most active manifestation, or in the state of chronic malarial poisoning, the colored blood corpuscles are destroyed in large numbers both in the liver and spleen.

It is reasonable therefore to refer the induration and atrophy of the liver in this case, in its first origin, to the action of the malaria.

In five cases observed by Frerichs, cirrhosis of the liver was preceded by persistent intermittent fever, a coincidence which has been repeatedly mentioned by other observers. Frerichs states however, that on the whole, granular infiltration of the liver is a rare lesion in individuals who have died from the cachexia of intermittent fever, and he had more frequently found either simple chronic atrophy or fatty, and occasionally, colloid infiltration. It would appear therefore, that other agencies must co-operate in the development of cirrhosis in intermittent fever, and the precise nature of these agencies is obscure. In an extensive series of observations on malarial fever I was unable to connect cirrhosis of the liver directly with the action and effects of the malarial poison, for many stout, athletic men, who were suddenly stricken down after a short illness of from one to four days, a few weeks after entering for the first time in their lives, a malarial region, presented marked cirrhosis of the liver. For in such cases, the disease was clearly referable to some antecedent cause. And in such investigations it should be borne in mind that a certain amount of cirrhosis may exist for a length of time, without any perceptible impairment of health; and without incapacitating stout laboring men from the daily performance of their arduous duties.

The three following cases of cirrhosis of the liver, recorded by Frerichs, are worthy of notice, inasmuch as they were preceded by obstinate intermittent fevers; in one of them not one of the causes existed which are wont to give rise to cirrhosis; in the two others, the abuse of spirituous liquors, etc., could not with certainty be excluded:

Case 687: *Persistent Intermittent Fever; Irregular Habits of Life; Gastric Catarrh; Slight Jaundice; Cachexia; Ascites; Paracentisis; Collapse.—Death. Autopsy.*—Finely-granular Cirrhosis of Liver; Splenic Tumor with slight pigment deposit; Catarrhal Tumefaction of the Mucous Membrane of the stomach; Cicatrices in the Duodenum; Typhus (sic) Cicatrices in the Ileum.

Case 688: Rosina Fritze, aged 28, was a patient in the Clinical Department of All Saint's Hospital, from the 14th of April to the 20th of May, 1857.

Up to the beginning of 1857, she had been at service in the country, working in the morning in the house, and in the afternoon, out of doors, and she had then been in the habit of drinking from one to two glasses of brandy daily. During the previous summer and autumn, she had suffered first for six weeks, and afterwards for four, from a tertian intermittent fever, for which she had been treated in the Ohlau Infirmary. During January and February, she seemed to have led a very irregular course of life. The patient stated that for four weeks before admission, her appetite had failed, and she had been troubled with a feeling of fullness in the right hypochondrium and epigastrium, and during the same period she had observed a swelling of the abdomen, and a pale, yellow tinge of the skin. Three weeks before, her feet had become swollen.

The patient was jaundiced, and remarkably emaciated; the skin was everywhere dry, fissured, and covered with branny scales; there were extensive ascites, and likewise slight enlargement of the veins upon the abdomen. The lower extremities were moderately œdematous; the upper were free from œdema.

Percussion of the chest presented nothing abnormal; loud, sibilant, and moist rales were audible over the back part of both lungs; the patient complained of a troublesome, dry cough. Heart normal.

The hepatic dullness was completely absent at the epigastrium; in the right mammary line it commenced at the sixth rib, and extended downwards about 4 centimetres (1.57 English inch); but the percussion tone was nowhere completely dull. The splenic dullness commenced at the eighth rib, but its lower margin could not be defined, owing to the ascites and the œdematous condition of the integuments. The abdomen was greatly distended by a large quantity of liquid and gas, but was nowhere tender. The tongue was coated yellow and dry. After the administration of Tincture of Colocynth, the bowels were freely moved; the stools were of a brown color. Urine scanty, scarcely 300 cubic centimetres, (10½ fluidounces), in the day, dark, reddish-brown, dense, with a reddish sediment of urates, and a small quantity of bile pigment; it was free from albumen. Pulse 80.

On the 19th, pulse 84; respiration 22. The ascites and dyspnœa were rapidly increasing; less jaundice; urine more scanty, only about 200 cubic centimetres, (about 7 fluidounces), in 24 hours, turbid, neutral and rapidly decomposing. The sediment contained a large quantity of globular lithates, also triple phosphates, and a few small octohedres of oxalate of lime.

The patient complained of pricking pains in the liver, and was very morose. Was ordered Infusion of Rhubarb.

On the 22d, pulse 84; respiration 24.

On the 30th, pulse 100; respiration 26; headache and bilious vomiting. For eight days, the jaundice had been diminishing, but the ascites had increased. The dyspnœa was more urgent, the secretion of urine had almost entirely ceased.

On the 5th of May, paracentisis was performed, and about five pounds of a bright yellow, perfectly clear fluid were drawn off from the abdomen.

On the 6th, pulse 90; respiration 26; had slept well. A large quantity of serum was flowing from the punctured wound. The region of the liver was tender when touched. Stools very scanty; no urine passed. * *

On the 16th, pulse 100; increased tenderness of the abdomen. Since the day before, the wound had completely closed, and the abdomen had rapidly increased in size.

On the 17th, pulse 96; bilious vomiting, increasing collapse.

On the 19th, pulse 100; abdomen greatly distended, but not very tender; frequent vomiting, and coldness of the extremities. The vomiting returned during the night, and, on the following morning, the patient died rather suddenly.

Autopsy.—Body extremely emaciated; no jaundice; no œdema of feet. * *

Four pounds of yellow, tolerably clear fluid in the abdominal cavity. Spleen 5½ inches long, 3¾ inches broad, 1 inch thick, flabby, reddish-brown, and infiltrated with bluish-black pigment.

Kidneys anæmic and of normal consistence.

Liver small and shriveled. A tight-luce furrow was observed on the right lobe. The parenchyma presented everywhere a granular character, and a dense, firm, leathery consistence. The granulations varied in size, from a pin's head to a linseed, and were separated by corresponding narrow rims of areolar tissue. The bile was scanty and pale, and contained a large quantity of mucus.

CASE 689: *Intermittent Fever of seven months' duration; Asctics; Hydræmia; Anasarca; Death from Œdema of the Lungs. Autopsy.*—A moderately enlarged pigment-spleen. Cirrhosis of the liver. Mucous membrane of the stomach and intestines, and likewise the kidneys, normal.

CASE 690: *Old Pleuritic Exudation; Persistent Intermittent Fever; Tubercle of both Lungs; Ascites; Bronzed Skin; Small Liver; Dyspeptic Symptoms. Autopsy.*—Firm adhesions of Pleura. Tubercle of the lungs. Cirrhosis of the liver. Super-renal capsules normal.

Spleen of moderate size, tolerably firm, and dark brown. Liver very small, uniformly granular, firm, tenacious, and of a yellowish brown color. Two concretions of a mulberry form in the gall-bladder. Supra-renal capsules in every respect normal. The cortical substance of the kidneys presented several cicatrix-like depressions, but in other respects these organs were healthy. (Clinical Treatise on Diseases of the Liver, Vol. ii. pp. 63–69).

CASE 691: *Dropsy resulting from Cirrhosis of the Liver and Cardiac Disease.*—This case of the stout seaman, William Woods, who died in ward No. 18, a few days after coming under my treatment, presents several points of interest, and the dropsical effusion in the cavity of the abdomen, and into the cellular tissue of the face, and upper and lower extremities, were due to both cardiac disease and cirrhosis of the liver. The following outline of this case will serve for comparative deductions:

William Woods, aged 47; dark hair, dark complexion; in health, a large, powerful, stout, athletic man; ship carpenter by trade; has been sick about two years; says that his disease commenced whilst working in the water; has always used ardent spirits daily, in large, or rather pretty free quantities.

Entered the Charity Hospital November 9th, 1868. At that time the abdomen was much distended with serous effusion, and it has been necessary to tap the abdomen upon several occasions, and several gallons of water have been drawn off.

When this patient came under my treatment, in the month of March, 1869, the complexion was of a wax-like, unhealthy, jaundiced hue; the features of the face were swollen and livid from venous congestion; the abdomen was distended with dropsical effusion, and the extremities were œdematous. Patient feeble, but able to sit up and walk about a little. Great obstruction of venous circulation; veins of neck distended with black blood. Lips livid. Arteries in all parts of the body, where they could be carefully examined, greatly enlarged and tortuous, with a powerful beat. The column of blood is sent out with great force from the heart, giving a powerful beat to the arteries, which appeared to be universally enlarged and degenerated. This degeneration of the arterial system is still farther shown by the *arcus senilis.* Great oppression in breathing. At times the restlessness and oppression very great.

Patient cannot lie down with comfort, but requires to be propped up in bed. Percussion and auscultation revealed dullness in the lower dependent portions of the lungs, and greater flatness over the chest than in health; there were no symptoms of pneumonia, or pleurisy, or of phthisis, and the dullness was referred wholly to the obstruction of the circulation. Heart greatly enlarged, with a powerful beat. The dullness, upon percussion, extends from the junction of the second rib with the sternum, to the lower edge of the seventh rib, and even beyond the right border of the sternum. The region of dullness, indicating the position of the enlarged heart, is eight inches in the longitudinal, and about six inches in the lateral, or transverse diameter.

The first sound of the heart is entirely altered to a low bellows sound, terminating abruptly by the powerful closure of the pulmonary and aortic valves. Both sounds of the heart are merged into one—a powerful, low, blowing sound, with a sharp, loud termination, thus: TU-U-CHUCK. The sounds of the heart resemble those made by an ordinary steam tug. The sounds of the heart are heard with great distinctness along the track of the large arteries, and especially of the carotids.

Abdomen greatly distended with serous effusion. Liver apparently diminished in size and hardened.

Derangement of the liver is evidenced aside from the ascites, by the yellow jaundiced hue of the complexion, and the great amount of bile in the urine. Œdema of extremities. Bowels constipated. Appetite poor. No marked febrile phenomena. Patient dull and lethargic, but calm and sensible.

The diagnosis of this case was:

Hypertrophy and Dilatation of Heart.

Universal Degeneration and Dilatation of Arterial System.

Great enlargement of Aorta.

Cirrhosis of Liver.

The dropsical effusion was referred directly to these causes.

The patient continued to grow worse; treatment was only palliative, and he died on the 27th of March, 1869.

The *Post-mortem Examination*, performed six hours after death, revealed enormous hypertrophy of the heart; this organ was eight inches in the longest diameter, and six and a half inches in transverse diameter, after being emptied of the dark venous blood which distended its cavities, and after being preserved in alcohol. During life, when distended with blood, its dimensions were much greater. All the cavities of the heart, but more especially the left ventricle, were dilated, and the auriculo-ventricular openings were greatly dilated. No thickening of the auriculo-ventricular valves was observed.

The valves of the aorta and pulmonary arteries were somewhat enlarged and perhaps degenerated, but no deficiency or adhesions or calcarious degeneration were observed.

Aorta and pulmonary artery; but especially the former, degenerated, roughened and dilated. The dilatation of the aorta amounted in the ascending portion and arch almost to an *aneurism*. The arteries were universally dilated and degenerated in their structure, and appeared in a great measure to have lost their elasticity. Microscopical examination showed that this dilatation and loss of elasticity was due to the conversion of the unstriped muscular fibres into fat. The liver presented a rough hob-nail appearance upon its exterior; it was contracted, diminished in size; the capsule was greatly thickened, and could be pealed off, and the structures were cirrhosed.

Kidneys congested, but healthy in structure—no degeneration or alteration of secretory textures.

Spleen somewhat enlarged.

This liver, as in all the other patients who had been exposed to the malarious climate of the Mississippi valley, presented a darker color than usual in cirrhosis, and also gave evidence in the dark granular masses of the preceding destruction of the colored blood corpuscles.

The dropsy in the preceding case was clearly referable to cirrhosis of the liver and cardiac disease.

CASE 692: *Cirrhosis of Liver; Chronic Dysentery; Ascites.*—John I. Ewing, age 29, native of Mississippi, Brakesman on Railroad.

Entered Charity Hospital, ward 13, bed 198, August 17th, 1872; died February 22d, 1873. Cause of disease, exposure to wet and cold, especially at night, combined with the habitual and excessive use of alcoholic liquors. Father and mother of patient healthy, up to the time of their death, from Typhoid Fever, in 1869. Light blue eyes; light brown and brownish red hair and beard; florid complexion; height 5 feet, 9 inches; weight in health 175 lbs.; enjoyed good health up to January, 1872. The only serious disease with which he has suffered was the Small-Pox. In January, 1872, suffered with severe pain in region of the liver, cramps in the abdomen and diarrhœa; continued working however, until the 1st of June.

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swelling commenced about the 1st of July, and the patient entered the Charity Hosp New Orleans, on the 17th of August. Has been in the habit of drinking strong ardent s (Whiskey and Brandy); his custom for several years, has been to take from one to drinks of (raw undiluted) Whiskey in the morning, before breakfast. The dropsical ef into the abdomen rapidly increased after his entrance into the hospital. Was tapped 26th, October 8th and October 15th. Abdomen distended with dropsical effusion. Ve abdomen distinct and arborescent in appearance. Lower extremities distended with Skin over legs covered with a scabby eruption. The dropsical swelling of the abdom definitely and abruptly bounded by the diaphragm above. Face, chest and arms, withou œdema, but thin and wasted. Action of heart feeble, but regular: *no cardiac derang* Upon percussion and auscultation the lungs also are found to be healthy. Respiration s what embarrassed, and difficulty of respiration, increased by exertion. The embarras of respiration appears to be due solely to the pressure of the fluid in the abdomen, w forces the diaphragm upwards. Urine high colored from the presence of bile. Careful mical and microscopical examination of the urine, demonstrated the absence of both al and casts and cells of the tubuli uriniferi. Kidneys apparently healthy, and performing normal functions. Bowels loose; actions often attended with pain, straining and m discharges streaked with blood.

The results of the preceding examination lead me to exclude the heart, kidneys and l from any connection with the dropsical effusion, and accordingly the following diag cirrhosis of the liver and chronic dysentery; anasarca of lower extremities and asci abdominal cavity, caused by the portal obstruction; *prognosis* unfavorable; life may be longed by treatment, but there is no chance whatever of recovery.

October 17th, I introduced the trochar and canula within the cavity of the abdomen drew off four gallons of clear, limpid, light yellow, serous fluid. Specific gravity of t fluid from cavity of the abdomen 1007.5. Microscopic examination revealed the prese numerous colorless blood-corpuscles and exudation spindle-shaped corpuscles. The s fluid from the abdomen was coagulated, both by heat and the mineral acids. Upon an 1000 parts of this serous fluid yielded 19.5 parts solid residue, of which 9.9 parts were albumen, and 8.7 parts salts and extractive matters. Each pint of the dropsical fluid yi 63.6 grains of dried albumen; each gallon 508.8 grains, and the entire quantity of fluid tained in the cavity of the abdomen (4 gallons,) yielded 2035.2 grains of dried alb Reaction of serous dropsical fluid, alkaline. Upon standing, a few small fibrous flocculi rated. The putrefactive process was slowly set up, and a number of vibros and fungi developed.

The 2035.2 grains of albumen contained in the whole amount of dropsical effusion, co ponded to the serum of 28,899.84 grains of blood, which equals the albumen of the ser 4.12 pounds Troy of blood.

The strength of the patient appeared to be increased by the tapping and the removal o dropsical effusion; the tension being thus removed, and the lungs and heart being relieve the pressure. A tight bandage was applied around the abdomen.

After the tapping, the dropsical effusion rapidly disappeared from the lower extremities the abdominal cavity commenced to fill up rapidly, and in 24 hours a perceptible accumul of fluid had taken place.

The pulse ranged from 100 to 110, and the temperature oscillated daily, between 9 and 101° F.

The dropsical effusion accumulated so rapidly, that it was necessary to tap the patient on the 26th of October, 9 days after the last tapping.

October 26th, A. M., abdomen enormously distended; diaphragm pushed upwards; brea embarrassed, action of heart feeble and irregular, mind wandering. I introduced the tr (paracentisis,) and drew off 5 gallons of light yellow serous fluid. The walls of the abd were somewhat thickened, especially the peritoneal coat; and there had been some tend of the abdomen, after the last tapping.

Specific gravity of dropsical fluid 1007.6; reaction alkaline. Under the microscop fluid contained colorless blood-corpuscles; 1000 parts contained dried solid residue 17.4 dried albumen 8.8 parts; extractive matters and salts 7.1 parts.

The entire amount of fluid from the abdomen (5 gallons,) contained 3100 grains of albumen.

The relief from the tapping was only temporary; the effusion disappeared from the extremities, and increased rapidly in the abdomen. The application of a tight bandage the belly, appeared to exert but slight influence in preventing the return of the dr effusion.

I determined to attempt the reduction of the dropsical effusion, by exciting the kid increased action; and accordingly on the 27th of October, commenced the administ regular intervals of 4 hours, of a powder composed of eight grains of powdered Sq and a half grains of powdered Digitalis and three and a half grains of Nitrate of P The sixth of a grain of Sulphate of Morphia, was also administered at bed time.

October 30th. Patient very weak; delirious; dropsical effusion increasing rapidly; urine high colored, free from albumen, but loaded with bile and urates; urea in normal amount. The Digitalis, Squill and Nitrate of Potassa were abandoned, and the patient placed upon a purgative mixture, composed of one ounce of the Bitartrate of Potassa, three-fourths of an ounce of Washed Sulphur, and twenty grains of powdered Jalap. This powder was mixed with a cup of water, and administered twice a day, in the morning and evening.

December 10th. The purgative powder has produced free action on the bowels, and also increased the flow of urine; the patient has improved, has gained some strength, the intellect is clear. The dropsical effusion has slowly decreased, and it has not been necessary again to resort to the operation of paracentisis.

When the action of the powders have been too great upon the bowels, only one-half or one-fourth of the quantity specified above was administered twice a day, and sometimes the medicihe was intermitted for 24 and 48 hours.

The actions on the bowels are attended with straining and pain, which symptom appears to be referable to the chronic dysentery, with which this patient had suffered for 12 months, before entering the hospital.

The entire amount of fluid removed from the abdomen by tapping has been 128 pounds; and upon careful analysis, I found that this amount of serous fluid contained an amount of albumen, which was equal to that contained in the serum of about 17 pounds of blood. As the whole amount of blood contained in the body of a man of this size, might be estimated at about 24 pounds, it is evident that from the 26th of September, to the 26th of October, (one month,) the greater portion of the albumen of the blood, that is an amount of albumen nearly equal to that contained at any one time, in the whole mass of blood, had been effused into the cavity of the abdomen.

Under the systematic employment of the Bitartrate of Potassa, Sulphur and Jalap, the dropsical effusion, was not only kept from accumulating, but was entirely removed; and to such an extent that the lower limbs presented a shrivelled appearance, and the abdomen reduced very nearly to the normal size in health.

When necessary, opiates were given to induce sleep, and the diet was nutritious; soft boiled eggs, mutton and beef, milk, rice and bread.

The Chronic Dysentery however, and the constant pain attending the action ot the bowels, slowly reduced the strength of the patient, whilst at the same time, the digestion and assimilation of food, were imperfectly performed, and the patient died December 30th, 1872.

Autopsy 12 hours after death.

Exterior.—Face, neck, arms and thorax greatly emaciated. Abdomen, flaccid and greatly reduced in size in comparison with its former dropsical condition. Lower extremities nearly normal in size and but slightly swollen.

Thorax.—Muscles normal in color; adipose tissue completely absorbed; pericardium and heart, normal in size and position; heart normal in all its parts. Pleura and lungs normal. Lungs without structural alteration or congestion.

Abdominal Cavity.—When the abdomen was opened, about thirty fluidounces of yellow serous fluid poured out. Surface of the peritoneum, rough and nodulated from the effusion of coagulable lymph. The fibrous nodules of the peritoneum varied in size from $\frac{1}{8}$ to $\frac{1}{12}$ of an inch in diameter. Sub-acute inflammation had evidently been excited in the peritoneum by tapping.

Alimentary Canal.—Stomach, normal. Jejunum and Ileum, somewhat congested, but healthy. Mucous membrane of large intestine studded with the cicatrices of old ulcers. Some of them appeared to have completely healed; in the rectum however, some of the ulcerated surfaces presented a bright congested appearance and appeared to be in a state of active inflammation.

Liver.—Color of liver yellow; surface nodulated and irregularly contracted. Weight of liver, 2 pounds and eleven ounces. Liver contracted and cirrhosed, the hardening being most marked in the Portal system of Capillaries bordering the individual lobuli. Whilst the portal periphery of each lobulus was hardened, the interior was softened, and contained much oil, within and around the hepatic cells. Under the microscope the excretory cells of the liver wêre filled with oil globules, and the oil was greatest in the centre of the lobuli in the meshes of the hepatic capillaries. Gall Bladder contained 1050 grains of bile.

Kidneys healthy. *Spleen normal.*

The diagnosis was fully sustained by the pôst-mortem examination, viz: *Cirrhosis of Liver and Chronic Dysentery.*

Case 693: *Enlarged nodulated Liver; Cirrhosis and Tubercular Deposit; Ascites; Jaundice.*—Ah Choo, Chinaman. Admitted to ward 30, bed 449, Charity Hospital, November 28th, 1874. Died December 10th, 1874. Diagnosis: Cirrhosis, and Tuberculosis of Liver. Prognosis unfavorable.

Patient says that he has been sick for several months. At the period of entrance the patient presented a golden hue, the sclerotic coats of the eyes being tinged of a deep yellow. Abdomen distended with dropsical effusion. Liver greatly enlarged, extending some 3 inches below the border of the false ribs. Urine loaded with bile and urates. The urates were in such abundance, that upon the addition of Nitric Acid, a heavy deposit resembling that caused by albumen, took place, but this was cleared up by heat.

When pressure was made over the region of the enlarged liver, the surface was felt hard and nodulated.

Patient died December 10th.

Autopsy 6 hours after death.

Liver greatly enlarged; of yellow color, with nodulated, irregular surface. Weight of liver 10 pounds. The entire organ was filled with hard circumscribed tubercular masses, varying in diameter from ¼ of an inch to 1½ inches. Under the microscope the nodular masses consisted of granular matter, small cells like those characteristic of tubercle, liver cells filled with oil, oil globules, and fibrous tissue.

CASE 694: *Congenital Enlargement and Cirrhosis of Liver; Ascites; Fever, and persistent Jaundice; Passive Hæmorrhages into Cellular Tissue; fatal result.*—Infant daughter of Doctor —— of New Orleans, born January 6th, 1874; labor natural; at birth the child appeared to be healthy, nursed well, and slept quietly. During the course of the 2d week, when light was admitted into the room, the infant was observed to be of a deep golden jaundiced hue. It was probable that the jaundice existed from birth, but it was not previously noticed because light had been excluded from the room. A few small doses of calomel were administered, but no apprehension was felt by the parents, as the infant appeared to be healthy in all respects, with the exception of the universal jaundice.

I was called in consultation about the middle of March, and upon careful examination, found the liver to be enlarged and indurated, the surface extending below the ribs, presenting a hard nodulated feeling when the hand was firmly pressed against it so as to displace the fluid which had been effused into the abdominal cavity. The liver extended across the epigastrium and encroached upon the left hypochondriac region; and on the right side it projected about three inches below the border of the ribs.

Diagnosis; Cirrhosis and Enlargement of Liver.

Prognosis unfavorable. I expressed the belief that the disease was necessarily fatal; that sooner or later Ascites would appear and increase to a distressing extent; that the blood would be gradually and profoundly altered by the retention of bile; and that treatment could only be palliative. Notwithstanding this condition, the child ate well, slept well and developed about as rapidly as other children of the same age.

About the end of the third month, the child began to suffer with fever and acute paroxysms of pain, which were most marked at night. The fever seldom, if ever entirely intermitted, and at times, the temperature was very high. The pain at times was agonizing; the little patient would scream, struggle, pull its hair, and bite its fingers and try to tear off its clothes. The urine was highly charged with bile, but at the same time the discharges from the bowels presented the normal color. Quinine, used by itself, and in combination with calomel, appeared to exert no influence upon the paroxysms of fever. A course of Iodine and Iodide of Potassium in like manner, appeared to accomplish no beneficial effects. At night the cries of the child were so incessant, and the pain and agony so great, that such sedatives as Tincture of Opium, Bromide of Potassium and Hydrate of Chloral were employed at regular intervals, and oftimes in relatively large doses. At times very large doses of these agents were necessary to induce short periods of rest. The intellect of the child, however, continued bright, and the appetite good, and the digestion apparently unimpaired. Liquid continued to accumulate in the abdominal cavity, and about the first of the eighth month, the ascites had increased to such an extent, as to greatly distend the belly, forcing up the diaphragm and impeding respiration. However, by the persistent and free use of the Bitartrate of Potash, in purgative and diurectic doses, the effusion was so far reduced and controlled, as to obviate the necessity of the tapping.

About the beginning of the 9th month, hæmorrhage occurred from a slight abrasion or ulcer on the frænum of the tongue, which continued at intervals of a week, and was restrained by the local and internal use of the Tincture of the Sesquichloride of Iron. There supervened a general hæmorrhagic condition. Hæmorrhages took place in the cellular tissue beneath the skin, in the legs, arms, body, head and face. The position of the local hæmorrhages were indicated by circumscribed, hard, dark colored, elevated tumors of various sizes, from one-half an inch to three inches in diameter. A free hæmorrhage into the cellular tissue occurred suddenly in the left cheek. Blood was poured out into the tissues, until the whole side of the face and the mouth was distorted. The whole cheek, both within (mucous surface) and without, presented a purplish, almost black color. The diameter of this clot appeared to be about three inches. The hæmorrhage into the cellular tissue of the left cheek occurred seven days before death. A hæmorrhage of about equal amount occurred in the cellular tissue of the right side of the head, above the temple.

Eighteen hours before death, a violent fever supervened, attended with cough, and great oppression of breathing, and finally, with stupor. Before death, the child vomited blood, and large quantities of bloody mucus issued from the mouth and nostrils.

The preceding case is of interest, as illustrating the effects of the bile upon the blood in inducing passive hæmorrhages in the cellular and muscular tissues, and from the mucous membrane of the mouth and stomach.

The effects which were slowly induced in this case, are rapidly manifested in severe cases of yellow-fever, in which, in addition to the action of a special fibrile poison, and the rapid and marked elevation of temperature, there is also induced intense jaundice.

We will consider briefly in the next place:

THE TREATMENT OF HEPATIC DROPSY.

The treatment of dropsy arising from portal obstruction, must depend, not only upon the cause of this condition, but also upon the various complications, as cardiac and renal disease. The preceding cases illustrate in a clear manner, the fact, that dropsy may be referred in the same case, to several causes, as cirrhosis of the liver, and cardiac disease; it is therefore absolutely essential that the physician, should, as far as possible, clearly recognize in each case the cause or prominent cause of the dropsical effusion. It would be foreign to our purpose, to discuss the mode of treatment applicable to all the diseases of the liver, which may give rise to ascites; and our effort will be to indicate briefly the mode of treatment of that form of dropsy illustrated by the preceding cases, viz: ascites arising from *cirrhosis of the liver.*

Cirrhosis of the liver is at the outset obscure and insidious, and is slow in its progress, often extending over several years: the physician therefore rarely has an opportunity of treating the disease at its commencement. When, however, the existence of the disease is indicated by the symptoms of disordered digestion, loss of appetite, flatulence, irregular action of the bowels, pain after food, dull pain, with slight tenderness in the right hypochondrium, and slight enlargement of the liver, occurring in a person addicted to spirit drinking, attention should at once be directed to the habits and diet of the patient. Alcoholic stimulants, and rich, indigestible, stimulating food and condiments, should be interdicted, and the patient confined to spare, but nutritious diet, consisting of such articles as milk, eggs, and farinaceous substances, with a moderate allowance of meat and fish. In order to avoid the occurrence of delirium tremens, it will be necessary in some cases in which the habit of taking large quantities of alcoholic stimulants has been fully established, to reduce the amount gradually. The bowels should be kept freely open, by saline purgatives, and occasional doses of blue mass and calomel; and the general health preserved by regular exercise in the open air.

If the pain and uneasiness, in the region of the liver, is well marked, sinapisms, leeches, dry cups and cut cups may be used over the affected organ, with benefit.

If the liver still remains enlarged, after the subsidence of pain, the alterative effects of Iodine—either locally, in the form of the tincture or ointment, over the region of the liver, or internally, in the form of the Iodides of Potassium and Iron, or of Lugol's Solution should be carefully tried. If these measures fail in reducing the liver, recourse may be had to the mineral acids, the Hydrochloric, Nitric and Nitro-muriatic Acid, internally, and to the Nitro-muriatic acid bath*.

When the stage of contraction of the liver sets in, as evinced by diminution of the area of hepatic dullness, jaundice and ascites, there appears to be no known treatment, which will restore the liver to its normal condition, or remove the obstruction to the portal circulation. In this stage the efforts of the physician are directed chiefly to the relief of symptoms, and the support of the patient's strength, in order that life may be prolonged to its farthest limit.

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*The Nitro-muriatic Acid Bath is prepared by adding two ounces of strong Hydrochloric Acid, and one ounce of strong Nitric Acid to two gallons of water, at 98° F. Deep, glazed, earthen or wooden vessels should be used, and the feet and legs are immersed in the bath, whilst the thighs and right side are sponged with the acid solution. The patient should remain in the bath from half an hour to one hour. The bath thus prepared should be renewed at least every third or fourth day.

The diet should be nutritious but not stimulant, alcoholic stimulants should be entirely prohibited, or used only in cases of emergency and with great caution; the digestion should be improved by such tonics as Quinine, Gentian, Nitro-muriatic Acid and Strychnia; and the bowels should be kept open, whenever sluggish, by mild purgatives.

The ascites should be treated by diuretics and purgatives. A pill composed of half a grain of powdered digitalis, one grain and a half of powdered squill and two grains of blue pill, has been administered with benefit in cases of ascites, dependent upon hepatic disease, two or three time daily.

The diuretics and purgatives previously recommended in the treatment of cardiac disease may be employed. As a rule, however, the ascites slowly increases, and sooner or later it is necessary to resort to the operation of paracentisis; this should be delayed as long as possible, for notwithstanding the temporary relief afforded, and the increased action of the kidneys, the fluid usually collects again rapidly, and the patient is exhausted by the great drain of albumen from the blood.

CHAPTER XV.

DROPSY ARISING FROM DERANGEMENT OR LESION OF THOSE ORGANS WHICH REGULATE THE AMOUNT OF THE BLOOD, AS WELL AS ITS CONSTITUTION, BY REGULATING THE AMOUNT OF THE WATERY ELEMENT, AND BY THE ELIMINATION OF EXCREMENTITIOUS MATERIAL. DROPSY ASISING FROM DISEASES OF THE KIDNEY. DROPSY RESULTING FROM BRIGHT'S DISEASE OF THE KIDNEY. BRIGHT'S DISEASE OF KIDNEY. ANASARCA. TREATMENT OF DROPSY ARISING FROM DISEASE OF KIDNEYS.

The kidneys not only regulate the amount of the watery element of the blood, but they also eliminate certain noxious substances, resulting from the metamorphosis of the tissues, and the chemical changes involved in the generation of the physical forces; any arrest or alteration or suppression of the action of these important organs, must, therefore, be followed by an accumulation of the watery element, and certain excrementitious matters in the blood, derangement in the processes of absorption and exhalation, and disturbance of the sympathetic and cerebro-spinal nervous system.

It has been estimated, upon reliable data, that the amount of water taken by an adult, in twenty-four hours, is, on an average, from one-half a fluidounce, to six-tenths or seven-tenths of an ounce for each pound avoir. of body weight; a man averaging 140 pounds, will therefore take about seventy to ninety fluidounces daily, and in ordinary diet, about twenty to thirty ounces of this are taken in the so-called solid food, and the remainder is drank as liquid of some kind.

But the amount taken, varies within wide limits, in different circumstances, and from individual peculiarities; some men take only sixty ounces—others as much as one hundred and twenty, or even more; more water is consumed in a dry than in a moist climate, and during great exertion, than during a period of rest. The mean amount of water excreted through the kidneys by different male adults, varies from thirty-five to eighty-one fluidounces a day. The variations in the amount of water excreted by the kidneys, will depend upon the varying quantity introduced into the system; and upon the varying quantity eliminated by the skin, lungs and bowels.

It results, from the preceding calculation, that the kidneys alone eliminate, during the year, in adult men, on an average, from eight hundred to eighteen hundred pounds of water. This great and continuous circulation of water through the living being is essential to the existence of life, and the performance of the various functions. Thus during the development of heat, and of the forces which work the animal machine, a portion of matter is chemically altered, decomposed and broken up into simpler forms; if these matters, as urea, uric acid and carbonic acid and urate of ammonia be not continuously removed, ill-health, and finally death, will result. To accomplish the continuous removal of the various useless and noxious substances, there is first, the almost universal solvent, water; second the circulatory apparatus, in which these substances are received, and by which they are distributed; third, special organs, as the lungs and kidneys, which separate these matters from the blood, and cast them out of the circle of living molecules. We are thus enabled to understand the reason why general dropsy so rapidly and so surely supervenes, when the function of the kidneys is arrested or materially impaired.

An additional cause of dropsy is also known to exist in certain diseases of the kidneys, viz: The constant loss of albumen by transudation through the capillaries and excretory tubes of these organs, and the consequent derangement of the composition of the blood.

The diseases of the kidneys, which are almost universally attended with dropsy, are:—

Congestion, and acute inflammation of the kidneys, occurring as a sequel to scarlatina.

Acute nephritis, caused by exposure to cold or wet.

Acute Bright's Disease ("croupous nephritis.") The course of this disease is always acute, and terminates either in recovery or death, in most cases, within a few days. It is a frequent complication of scarlatina. Post-mortem examination shows the kidneys to be congested, enlarged, with the urinary tubes filled up and occluded with an extravasation, consisting of a coagulating exudation containing epithelial cells and blood corpuscles.

Chronic Bright's Disease, ("parenchymatous nephritis.") The pre-disposing causes of Bright's Disease, are, cold; incautious exhibition of certain irritating diuretics, as cubebs, copaiba and oil of turpentine; the abuse of ardent spirits; the alcohol eliminated with the urine acting locally upon the structures of the kidneys, the disease appearing almost as frequently among hard drinkers as cirrhosis of the liver; tedious suppuration accompanying caries and necrosis of the bones; the conditions of dyscrasia occasioned by gout, rachitis, scrofula and malarial cachexia.

In the *so-called* large white kidney, the cortex is pale and hypertrophied, and the uriniferous tubes crammed with granular epithelium. The large white kidney is often merely an advanced stage of acute nephritis, but it may also be developed independently, as the result of chronic inflammation.

In the fatty kidney, the organ is large and pale, and the secreting cells loaded with oil; and the observations of pathologists render it probable that this stage is preceded by the stage of exudation, characteristic of the large, white kidney.

On the other hand, in the two common forms of chronic kidney disease, characterized by the contracted, granular, or gouty kidney, and the waxy, or amyloid kidney, anasarca rarely shows itself, except shortly before the fatal termination.

Dropsy arising from renal disease, has the following distinguishing characters.

The anasarca of the sub-cutaneous areolar tissue, is general from the first, and most generally noticed first in the face; fluid is also almost always effused into the pleuræ, pericardium and peritoneum. The urine is scant, turbid or smoky, containing large quantities of albumen and sometimes blood; also renal epithelium and casts of the uriniferous tubes, varying in their character, according to the particular disease of the kidney. The countenance is swollen, heavy and pale, with a peculiar wax-like appearance. There is a tendency to nervous disturbances, convulsions, loss of memory, restlessness, delirium and coma. The digestion is deranged, with dry tongue, fœtid breath, and obstinate vomiting.

In the production of the anasarca, which accompanies and forms a prominent symptom in certain diseases of the kidney, several causes are in operation.

1st. In the acute affections, when dropsy comes on rapidly in a few hours, and is almost the first indication of the disease, this symptom is most probably produced by the retention in the blood-vessel system, of the water, urea and salts, which should be eliminated in the form of urine. The anasarca comes on before any great amount of albumen has been thrown off from the blood by the kidneys; the blood is still rich in this constituent, and the change in the blood results rather from a relative increase in the watery element, and the retention of those noxious compounds, as urea, which should be continuously eliminated. The circulation of the blood through the capillaries, depends, not alone upon the continuous action of the heart, but also upon the relations of the blood to the capillaries and to the organs and tissues through which it circulates; whatever, therefore, alters the constitution of the blood, deranges the capillary circulation, by deranging the chemical affinities of the blood and tissues, and by deranging the action of those portions of the nervous system which preside over and regulate the amount and character of the capillary circulation. If water be injected into the blood-vessel system of living animals to an extent greater than that which may be readily and rapidly overcome by the kidneys, congestions of important organs, and serous transudations will speedily result. Whether the view be held that urea, as urea, acts as a poison, or it be maintained that the poisonous effects resulting from the injection or retention of this substance in the blood, be due to certain changes of the chemical constitution in the urea, in consequence of which it is converted into a more active substance, viz: carbonate of ammonia; the cause of the anasarca is, with equal justice, traced, in part at least, to the paralyzing or deleterious influence of certain excrementitious matters upon the nervous system, heart, smaller arteries and capillaries.

2. In chronic Bright's Disease, in addition to the retention, to a great extent, of the watery element, and the consequent distention and relaxation of the swollen arterial branches and capillaries, and the retention of the poisonous urinous excrements, there is a continuous and great loss of albumen, which results in the production of a thin, poisoned blood, and the consequent derangement of the nutrition, circulation and functions of the organs and tissues. The researches of Gregory, Bostock, Christison, Andral and Gavarret, Becquerel and Rodier, have shown clearly, that a diminished proportion of albumen, and a consequent decrease in the density of the serum, constitute the leading changes of the blood in Bright's Disease, and from which may be deduced, in part at least, the pathogenesis of the dropsy developed under such circumstances. The diminution of the albumen, as well as the extent of the dropsy, bear a relationship to the duration of the disease, being much less in acute than in chronic Bright's Disease. The diminution of the proportion of albumen in the blood, is scarcely perceptible in the acute stage, before the fourth day. A great change takes place in the blood in chronic Bright's Disease, its mean density falling from 1060 to 1045.6; the globules fall likewise, whilst the fibrin is somewhat increased; the serum likewise undergoes a considerable change, the mean specific gravity being represented by 1021; and the albumen being so much diminished, that its mean is represented by 55.

The three succeeding cases illustrate the effects of cold in producing those changes in the kidneys, which lead to the establishment of this form of dropsy.

Case 695: *Bright's Disease; Anasarca; Ascites; Exciting Cause of Disease, Cold and Exposure.*—Clemens Schwerer, age 48; native of Germany; occupation, seaman. Has always enjoyed good health up to his present illness. Entered Ward 25, Charity Hospital, January 11th, 1871. About the 1st of December, 1871, took cold on ship-board, after being wet by a cold, driving rain. Suffered with diarrhœa at this time, and two weeks after taking cold from the wetting and exposure, noticed that his extremities, especially his legs, were swollen. Suffered with dull pains in the head and in the small of the back, and observed that the urine became very scant and high colored.

At the time of his entrance into the Charity Hospital, the face was puffed and swollen; the extremities, especially the legs, were œdematous and greatly distended with serous effusion. The urine was scant, high colored, and loaded with casts of the urinary tubes, and albumen.

Under the use of Cream of Tartar, Juniper berry tea, and Extract of Squill, the dropsical effusion was completely removed; the limbs and face returned to their normal size, and the urine became abundant and light colored, and the amount of albumen diminished greatly.

During the night of the 5th of February, however, the patient slept with the window at the head of his bed raised; a sudden cold change occurred during the night, and upon the next day I found the urine scant, and loaded with blood—in fact, when passed, it resembled, to the naked eye, fluid blood. Both chemical and microscopical analysis showed that the urine consisted, to a large degree, of blood.

Counter-irritants were applied to the spine and over the region of the kidneys; the diet was reduced to farinaceous articles; the patient was rigidly confined to bed; the function of the skin was promoted by the hot air bath; and the function of the kidneys was excited gently by Cream of Tartar, administered in flaxseed tea, conjoined with the Extract of Squill. The effects of the congestion of the kidneys, consequent upon the action of cold, was almost immediately evident, in the return of the œdema.

Under the measures just indicated, the patient improved steadily, and on the 23d of February, the urine was free from blood, and presented the normal, light yellow color. This patient improved steadily, and on the 1st of April was discharged at his own request.

Case 696: *Dropsy Arising from Exposure, Cold and Alcoholic Drinks.*—Henry Neimer, Butcher, age 32; native of Germany. Has lived in Louisiana 17 years, and followed the occupation of butcher. Has never had malarial fever. Has been in the habit of rising at 2 o'clock in the morning, and has been much exposed to wet and cold. Has been in the habit of drinking alcoholic stimulants freely. Had an attack of anasarca with ascites, in November, 1870, and after remaining in ward 22, Charity Hospital, for 1 month, was relieved to a considerable extent, and went out and renewed his old occupation; but the dropsy returned again upon exposure, and he re-entered the Charity Hospital, ward 24, on the 14th of February, 1871.

The bowels were regulated by gentle purgatives, and the kidneys excited by Squill and Cream of Tartar, and the condition of the blood was improved by Quinine and Muriated Tincture of Iron; and this patient was discharged from the Hospital on the 13th of April.

Case 697: *Anasarca; Ascites; resulting from Cold and Abuse of Alcoholic Stimulants.*—Thomas Moran, age 38; height, 6 feet; native of Ireland; has lived in Louisiana during the last 26 years, running on steamboats on Mississippi and its tributaries. Had chills and fever in 1851, and bilious fever in 1863, and chills and fever again in 1867 and 1868.

Served in the Confederate Army, and lost a finger in the service, and had bilious fever which affected him for about 5 months in 1863. Habits at times irregular and intemperate. "When on a spree would drink two or three bottles of whiskey during the 24 hours." Has been in the habit of taking four or five drinks daily.

Has had three attacks of dropsy; first attack eighteen months ago, took cold at night whilst watching on the levee of this city—got wet in the rain, and the wind changing suddenly to the North, and the temperature becoming suddenly cold, he was thoroughly chilled. Œdema followed by general anasarca and ascites, commenced a few days after the exposure to the cold rain, and continued five weeks. Patient says that during this attack he had no regular medical attendance, but took on his own account salt and oil; and under this regular purgative, the dropsical swelling progressively declined and disappeared. During this attack he did not intermit daily work. The second attack occurred six months after, in the month of July, 1869; cold was in like manner the exciting cause; was acting as a butcher, and carried his meat around to the markets at night, and took cold after being exposed to a cool rain all night. The swelling in this attack lasted two months, and he had no medicine, except that which he took himself, viz: Castor Oil, Epsom Salts and Lemonade.

The third and last attack occurred about the 1st of July, 1870; worked in an ice house; entered the cold ice chamber whilst in a profuse perspiration. The sudden check of perspiration was followed by dull pain in the region of the kidneys, and the lower extremities commenced to swell two or three days afterwards.

Entered ward 25, bed 374, Charity Hospital, February 1st, 1871; abdomen greatly distended with dropsical effusion; blood-vessels of surface of abdomen prominent and arborescent; dropsical effusion into the abdomen, bounded very distinctly by the diaphragm; face and upper extremities emaciated as well as the thorax; lower extremities and scrotum, and penis, distended with the dropsical effusion. Urine high colored and loaded with biliary matters and albumen. No disease of heart or lungs.

Diagnosis: Cirrhosis of Liver; Bright's Disease of Kidney. Dropsical effusion clearly referable to both the Liver and Kidney diseases. This diagnosis was confirmed not only by the presence of biliary matters and albumen in the urine, but also from the unsatisfactory effects of both purgatives and diuretics in the treatment of the case. These agents hardly restrained the dropsy within its original limits, and at the end of three weeks I found it necessary to tap the abdomen. About 1½ gallons of serous fluid were drawn off with temporary relief. When I resigned the ward, at the close of my regular annual term of service, on the 16th April, this patient was in pretty much the same condition.

Case 698: *Dropsy resulting from Bright's Disease of the Kidneys.*—Frederick Mayer; aged 30 years; height 5 feet 7 inches; weight 160 pounds; light, sandy colored hair; blue eyes, fair complexion; native of Sweden; laborer by occupation; has generally enjoyed good health, with the exception of chills and fever in the last two years.

Admitted March 21st, 1869, to Charity Hospital, ward 29, bed 422; œdema of the lower extremities; scrotum and penis greatly distended with serous effusion; some effusion in abdominal cavity; face puffed; complexion sallow and wax like; action of heart somewhat irregular, with a slight murmur in the first sound; slight cough attended with pain, referred to the præcordial region; cough most troublesome during the night; very slight expectoration; percussion sounds over lungs duller than in health, indicating œdema of those organs, with some pleuritic effusion. Patient has a large and well formed chest and there are no symptoms of tuberculosis. No enlargement of the heart was detected, and the cardiac murmur was referred chiefly to the anæmic state of the blood. Bowels regular. The diagnosis that this was a case of Bright's Disease, was still further confirmed by an examination of the urine. Heat and nitric acid showed the presence of albumen in the urine and casts of the urinary tubes of the kidneys were detected in moderate abundance under the microscope.

The bowels were opened freely with Compound Cathartic Pills, and the attempt was made to excite and increase the action of the kidneys, by the Cream of Tartar and Juniper Berry

viously described. Under this treatment the urine increased in amount, the pulse
ular; the tongue cleaned; the bowels were moved regularly every day; and the
ame more active and cheerful, and there was a marked diminution of the anasarca.
—Amount of urine passed f. ozs lxxvi; pale yellow; specific gravity, 1013; upon
of heat, the albumen, after coagulation, filled one-fifth of the test-tube.

.—Pulse 76; respiration 20; tongue clean, appetite good; bowels regular; sallow,
wax-like complexion. Amount of urine passed, f. ozs. lxxvi; specific gravity,
r colored; contains casts of tubuli uriniferi and albumen. Under the use of the
Tartar and Juniper Berry tea, the swelling is slowly diminishing, and the general
of the patient improving.

ent under the persistent use of diuretics and gentle purgatives and simple but nutri-
slowly improved, and left the hospital at the end of April; the swelling had not
isappeared, but the patient left of his own accord.

tion was again called to this patient in the month of August, 1869; he had returned
pital in a most distressing condition, with general anasarca, and the abdomen
y distended with dropsical effusion. The scrotum was so greatly distended that
rst, and from the cracks the serous fluid issued.

ent was not then under my treatment, and I was not informed what measures were
for his relief, beyond the free use of squill and calomel. The patient died about
of September; no post-mortem was held as his friends claimed the body.

: *Dropsy resulting from Bright's Disease of the Kidneys.*—John Shone. The patient
llowing history: Was admitted to Charity Hospital in 1858, with what he terms
r, and was discharged in one week, after which time was attacked with dropsy,
entered the Marine Hospital, where he remained three weeks. The dropsy was
d he enjoyed good health for the space of two years; at the end of which time he
e afflicted with periodic headaches and vomiting.

the Charity Hospital, on the first of February, 1869, and was treated for albumi-
left of his own accord, on the 16th, and returned again on the 5th of March. The
pears to have been benefitted by a mixture composed of Tincture of Sesquichloride
gitalis and Nux Vomica. Purgation is said to have given the greatest relief to the
head and vomiting.

der my treatment in ward 18, bed 264, on the 26th March, 1869. Age 26; height
ght and a half inches; weight in health one hundred and eighty-five pounds, at the
e one hundred and seventy-two pounds; has a large and well proportioned frame;
air red and sandy; eyes blue; complexion in health florid; native of Germany;
s no hereditary tendencies as far as known.

tion sallow, and of a waxen hue; bowels constipated, except when moved by pur-
kin soft and moist; tongue red around the edge and tip; pulse regular; impulse of
lar, but a murmur is heard over the region of the aortic valves, synchronous with
pulse of the heart; respiration natural; temperature of axilla 98°.5 F. The
e full, swollen and œdematous, and the cheeks hang in a dead flabby manner, and
sion of the countenance is heavy, though not disagreeable, and there is no expres-
in or distress. The cellular tissue generally of the body, and especially of the
emities, is œdematous and pits when pressed, and the pits formed by the pressure
gers remain for a great length of time. The urinary secretion is abundant, and
oth albumen and casts. The patient suffers, periodically about every seven days,
ks of severe headache and vomiting. The patient was placed upon the Cream of
xture as a diuretic, and the bowels kept open by the compound Jalap powder mixed
s.

h.—The condition of the patient much the same; his spells of vomiting have not
o frequently; suffers with considerable dyspnœa during the spells of headache and
The amount of albumen has decreased somewhat, ranging from one-eight to one-
moist volume. The patient is still taking the infusion of Juniper Berries and Cream
together with the Tincture of Muriate of Iron.

d.—Patient suffering greatly with dyspnœa; pale, anæmic; action of heart tumul-
reat difficulty in filling the lungs; the left lung is dull upon percussion, from the
n or borders of the ribs upwards to the nipple, between the fourth and fifth ribs.
ful examination of the patient in the sitting and recumbent posture, it is evident
nsiderable amount of fluid has been effused into the pleural cavity of the left lung,
ing and embarrassing its action. Right lung more resonant than left, but there is
some effusion upon this side also. Dullness upon percussion, over region of heart,
han normal. Action of heart irregular, and sounds indistinct; blowing sound with
ound, whilst the second sound is prolonged. Serous effusion in abdominal cavity,
erness in epigastric and hypochondriac regions.

lowing table will present in a condensed form some of the chief symptoms;

DATE.	Pulse.........	Respiration..	Temperature of Axilla.	CHARACTERS OF URINE,				REMARKS.
				Am't in 24 hrs. in ozs.	Sp. Gr.	Color.	Albumen.	
			F.					
April 1st, 1869, 9 A. M.	72	18	98.5	68	1010	reddish	1/6	
" 2d, "	72	18	98.5	110	1010	yellow	1/4	In bed and suffering with headache.
" 3d, 1869, 5 P. M.	72	18	99.5	110	1010	amber	1/4	
" 4th, 1869, 9 A. M.	70	18	98.	150	1010	pale	1/4	Headache.
" 5th, "	70	18	99.5	45	1014	yellow	1/3	
" 6th, "	80	...	99.	72	1013	...	1/4	
" 7th, "	82	...	99.2	75	1012	...	1/8	
" 8th, "	82	...	98.5	75	1012	...	1/8	
" 8th, 1869, 6 P. M.	86	...	100.5	100	1010	...	1/8	
" 9th, 1869, 9 A. M.	83	...	100.	100	1010	...	1/8	
" 10th, "	88	22	99.5	83	1010	...	1/8	
" 12-13.................	88	...	99.	80	1010	...	1/8	During night headache.
" 14th, 9 A. M.........	90	...	99.	85	1010	...	1/4	
" 15-16	90	...	99.	75–85	1010	...	1/8	
" 17-20................	80	...	99–100	65	1010	...	1/8	
" 21st, 9 A. M	90	...	99.2	50	1014	...	1/3	On 20th, headache and vomiting.
" 22d, "	96	...	100.7	60	1010	...	1/4	
" 24-25, "	80	...	100.5	60	1010	...	1/8	Do. do.
" 26th, "	82	...	100.5	80	1009	...	1/8	Do. do.
" 27th–May 1st......	80	...	100.5	100	1009	...	1/8	Headache.
May 2d–9th	82	...	100.	70	1010	...	1/4	
" 11-15................	82	...	99.5–10	35–75	1010	...	1/4–1/10	Headache and dyspnœa.
" 16-24................	82	...	99.	40–50	1010	...	1/8–1/12	
" 25-30................	80	...	99.	35–65	1010–1012	...	1/8–1/12	
June 6th....................	80	...	99.5	40–65	1012	...	1/8–1/12	

In conjunction with Dr. B. A. Pope, this patient, together with several other cases of Bright's Disease, under my treatment, were subjected to a careful examination with the ophthalmoscope; the characteristic alterations of the retina indicative of Bright's Disease, were discovered, although they were absent in other cases of this disease; thus showing that the ophthalmoscope is incapable of indicating the disease in all cases.

This patient left the ward for another on the 23d of June, and passed from my care and treatment.

I was informed that after the transfer, the diuretics and purgatives were discontinued, and the dropsy rapidly increased, and the patient died about the middle of July.

In this case, the dropsical effusion was restrained within certain limits by the judicious use of diuretics and purgatives, and as soon as they were discontinued, death speedily ensued.

CASE 700: *Dropsy Resulting from Bright's Disease of Kidney.*—Charles Daley, age 60, height 5 feet 5 inches, weight in health 140 lbs.; left leg shorter than right, from having had compound fracture of both tibia and fibula; the patella is now quite prominent; black hair, hazel eyes, florid complexion in health; native of Ireland, laborer; no constitutional tendencies as far as could be gathered from statements concerning the health and diseases of his relatives; has never had syphilis or scrofula; has been in the habit of drinking whisky freely, at times to excess, for forty years; has enjoyed pretty good health, with the exception of a spell of chill and fever about five years ago.

Was admitted to the Charity Hospital on the 15th March, 1869, ward 29, bed 429, with general anasarca and with albuminous urine. The anasarca appears to have come on gradually.

Complexion sallow, and of a waxy appearance. Features swollen. Trunk and extremities œdematous; pressure causes pits which disappear very slowly. Appetite and spirits very good, but muscular and nervous forces depressed. Diagnosis; Bright's Disease of the kidneys.

The patient was placed upon the Cream of Tartar and Juniper-Berry Tea, Tincture of the Sesquichloride of Iron and nutritious diet, and the bowels were kept gently open by saline purgatives.

March 30th.—Patient appears to be improving; the amount of urine has increased; the complexion is somewhat clearer, and the anasarca has disappeared to a considerable extent.

Weight at the present time about one hundred and twenty pounds. Patient cheerful, with a good expression of eyes, but is very weak and confined to bed most of the time. Bowels regular; skin softer and more moist. Tongue natural. Urine loaded with albumen and casts.

The following table will exhibit some of the more prominent symptoms:

DATE.	Pulse	Respiration	Temperature of hand.	Temperature of axilla.	Complexion	Decubitus	CHARACTERS OF URINE.			
							Am't of Urine in 24 hours, f. oz.	Specific Gravity	Color of Urine.	ABNORMAL CONSTITUENTS.
April 1st, 1869, 9 A. M.	75	18	......	98.	Sallow.	Confin'd	52	1008	Pale	Albumen,
" 2d, "	75	18	......	98.	Waxy	to bed.	34	1010	Yellow	Casts of Tubuli Uriniferi.
" 3d, "	75	18	83°5	97.5	features	Lies on	30	1010	...	¼ albumen.
" 3d, 1869, 5 P. M.	75	18	......	99.5	swollen.	back.	30	1010	...	¼ "
" 4th, 1869, 9 A. M.	98	25	......	98.	...	...	32	1010	...	½ "
" 5th, "	...	...	......	97.5	...	...	40	1010	...	¼ "
" 6th, "	...	...	......	97.5	...	...	38	1008	...	⅙ "
" 7th, "	...	...	......	......	...	...	35	1010	...	⅙ "
" 8th, 1869, 6 P. M.	...	...	......	1005	...	...	35	......	...	⅓ "
" 9th, 1869, 9 A. M.	...	...	......	98.5	...	...	8	1016	...	5-6 "
" 10th, "	98	26	......	98.5	...	...	11	1025	...	

April 10th.—Lungs dull upon percussion, and there is a decided increase of heat every day towards night. The urinary secretion progressively decreased, and with this decrease the swelling increased in the cellular tissue and abdominal cavity.

On the 12th of April, the patient got out of bed, and passed a portion of the day on the gallery in the rear of the ward. The day was damp, rainy and cold. From this exposure the patient contracted a severe bronchitis, which seemed to prostrate him greatly, and he gradually grew worse, and died on the 5th of May. Death was preceded by convulsions and coma.

The post-mortem examination revealed adhesions of the liver, stomach, heart and lungs to their respective serous cavities and membranes; the liver was congested; spleen normal; lungs contained miliary tubercles; kidneys in a state of fatty degeneration.

CASE 701: *Dropsy resulting from Bright's Disease of the Kidneys.*—John Crowley, seaman; native of Pennsylvania; age 27. No hereditary tendencies can be traced. Had syphilis twelve years ago; the disease is said to have yielded readily to treatment, and disappeared in three weeks. Well made, muscular man, with full, well developed chest; blue eyes, light yellow hair. During his sea-faring life has been in the habit of using strong alcoholic stimulants freely. During a portion of his life has acted as fireman on board steamship, and whilst performing his duty, would frequently be exposed to sudden changes of temperature, and to wet and cold, and at such times would indulge freely in alcoholic stimulants. Enjoyed good health up to the last twelve months, when he was shipwrecked, and remained in the water some nine hours, and contracted a severe cold, from the effects of which the patient has suffered, in the way of a slight cough, up to the present time.

Entered Charity Hospital, ward No. 13, bed 199, December 8th, 1869. Features of face swollen; slight serous effusion in abdominal cavity; lower extremities œdematous, pitting on pressure; scrotum swollen; complexion has a sallow, wax-like appearance; urine albuminous, and, under the microscope, loaded with casts of the tubuli uriniferi. Upon auscultation, sub-crepitant rales are heard in the anterior portion of the right lung, referred to chronic irritation of the bronchial tubes; no signs of tubercular deposit were discovered. The heart sounds are not altogether normal, and the soft murmur was referred to the anæmic condition of the blood. Liver slightly enlarged. Excretion of kidneys augmented; the amount of urine passed daily ranging from eighty-eight to one hundred and eleven fluidounces, of low specific gravity, ranging from 1008 to 1009. Patient says that during the last three weeks he has been easily fatigued, and during the last twelve months, has suffered with pain in his back, in the region of the kidneys, but has been following his usual occupation to within the last month. Temperature of axilla 98°.8 F.; pulse 72; respiration 18. Amount of urine passed during the last 24 hours 88 fluidounces; sp. gr. 1009. When the urine was subjected to the action of heat and nitric acid, the moist, coagulated albumen filled one-fifth of the test-tube. The patient was placed upon the Cream of Tartar, and Juniper berry tea, Tincture of Sesquichloride of Iron and simple but nutritious diet.

December 18th.—The apex beat of the heart is most forcible to the left of nipple; percussion also renders it probable that the left ventricle is hypertrophied to some extent. Auscultation over region of heart reveals a soft murmur, heard loudest over base of the heart during second sound; it is also heard at apex, with loss of murmur over body of heart, the sound being transmitted along arch of aorta, but not from apex towards spinal column. The veins of the upper portion of the chest are somewhat enlarged and congested. Patient suffers with cough and oppression of breathing after exertion. The respiration is prolonged with considerable ronchus, with a few sibilant rales. The lungs are duller upon percussion than in health, and there is some effusion in both pleura. The dullness upon percussion appears to be due in part, also especially in the infra-clavicular and clavicular regions, to œdema of the pulmonary tissue. The cardiac murmur is probably due, not only to the anæmic state of the blood, but also to fatty or calcareous degeneration of the aortic valves, permitting some regurgitation of the blood into the left ventricle. The urine contains albumen in abundance, with casts of the tubuli uriniferi. The amount of urine passed during the twenty-four hours has ranged from sixty to one hundred fluidounces. The temperature of the axilla ranged, in the morning, from 99° to 100° F., and in the evening, from 99°.5 to 101°.

Under the use of the diuretics and gentle purgatives, the anasarca has slowly diminished, and the patient appears to be more comfortable. There are times, however, when the nervous system is much disturbed, (headache, restlessness and dilatation of the pupils), apparently from the retention of the constituents of the urine.

Dec. 20th.—In addition to the preceding treatment, the warm bath at bed-time, and the steam bath, (prepared by heating a brick and pouring water over it while under the bed clothes), were ordered; and as a tonic and gentle stimulant, a tablespoonful of Huxham's Tincture of Bark, three times a day, one hour before each meal.

Dec. 21st.—In order still further to act upon the skin and kidneys, Syrup of Squills and Syrup of Ipecac were ordered in doses just sufficient to induce nausea, but not vomiting.

Dec. 31st.—During the past twenty-four hours has been affected with vomiting; pupils greatly dilated, with dull pain in head, lethargy of intellect and imperfect vision. At times one pupil is dilated and the other contracted.

January 3d.—Vomiting and dilatation of pupils continue.

January 10th.—Patient feels much better than he did a week ago, has ceased to vomit, and the pupils are not dilated.

January 13th.—Condition appears to be improved, the œdema has almost entirely disappeared; the lungs also are much less dull upon percussion. The same treatment has been continued up to the present time.

January 24th.—Patient has not been doing so well during the past five days. The Cream of Tartar mixture has disagreed with his stomach, and it has been necessary to intermit the diuretic. Pupils dilated. Œdema of extremities increasing. The cessation of the diuretic medicine has been attended with a marked diminution of urine, only twenty-nine fluidounces, of low sp. gr. (1010) were excreted during the past twenty-four hours. The amount of albumen in the urine has also increased, and it now reaches one-fourth of the volume in the test-tube, when heat is applied. The bowels were opened by ten grains of the Extract of Rhubarb, and on the following morning the patient appeared to be less lethargic and more cheerful, and the pupils were not so widely dilated.

January 26th.—Patient rested badly during the night; complains of pain in the lower part of the abdomen; pupils of eyes greatly dilated; nervous and restless; oppression in breathing; stomach very irritable, obstinate vomiting whenever the Cream of Tartar mixture is administered. Four grains of Iodide Potassium were substituted, three times a day.

January 28th.—Patient rested badly and was disturbed by frightful dreams. Pupils still more dilated; stomach irritable. Œdema increasing.

January 29th.—Rest imperfect and troubled; pupils dilated; patient feels very weak and depressed.

February 1st.—Cough and oppression of breathing increasing; patient weak, and depressed, and nervous; can retain but little upon his stomach, from the nausea and vomiting. It is impossible to administer sufficient medicine to act upon the kidneys which secrete not one-half the former amount of urine. The urine is not only diminished in amount, but it is of low sp. gr., (1010), and loaded with albumen and casts. It is evident that the constituents of the urine are but partially eliminated. The warm bath and the hot air bath fulfil the office of the diuretic mixture but imperfectly.

February 8th.—The condition of the patient has continued steadily to grow worse, the nervous symptoms increasing, and the anasarca in like manner augmenting. Patient very weak, unable to get out of bed, and passes his urine in small quantities and involuntarily. The patient lies in a dull, lethargic state, with pupils widely dilated, as if under the influence of some powerful narcotic poison. Urine scant, and loaded with albumen and urinary casts.

February 9th.—Continues to grow worse, and more feeble; is not able to move in bed without suffering great pain; has been vomiting almost incessantly during the past twenty-four hours; the fluid ejected resembles milk. Urinary excretion suppressed, bowels constipated, constant hiccough.

February 10th.—Vomiting continues, but the matters ejected have changed color, being green instead of white. Pupils greatly dilated, muscles of extremities trembling, intellect dull and lethargic; when aroused, appears to be under the influence of some powerful poison.

htest touch upon the surface causes pain. The patient continued in this state, with , and hiccough, and suppression of urine, and died February 11th.

llowing table (page 644) presents the changes of the pulse, respiration, and temper- d the amounts of urine.

nber of other cases of Bright's Disease have been under observation during our service in the Charity Hospital, and careful post-mortem examinations were the presence of the Medical Class; and it was observed that the degeneration dneys was frequently associated with fatty degeneration of the liver, heart and These diseases occur most commonly in the ill-fed and ill-conditioned laborers kards, who consume the alcoholic stimulants undiluted, and to a great extent e them for more substantial food. Fatty degeneration, cirrhosis of the liver, ght's Disease of the kidney, appear therefore to depend in a measure upon auses.

lso worthy of note that the temperature in this class of diseases, does not rise eight that it does in phthisis and idiopathic fevers; but still the temperature unk is elevated above that of health, and is also subject to morbid perturba-

ruth of this observation might be illustrated by numerous observations upon iseases, recorded under our direction, but these must be deferred for the

ll conclude these observations on the different causes of dropsy, with some gen- rvations on the

ATMENT OF DROPSY ARISING FROM BRIGHT'S DISEASE OF THE KIDNEYS.

are so many minute yet important modifications, depending upon constitutional ies, habits of life, and special conditions of age, climate, and inherited or ac- nstitutions, that it is difficult to describe in detail, the treatment of any dis- l the attempt is especially difficult in diseases of the kidney. We shall there- upt nothing more than the indication of those general principles of treatment ould be kept at all times clearly in view. The student should ever remember escription, however minute, will relieve him of the duty of studying each case by the bed-side, and of adapting his remedial agents and measures to the the disease, and the symptoms and the natural or acquired constitution of each

onic disease of the kidneys, it is almost always necessary to continue the plan ent persistently for a length of time; and without general principles, only tment will result from the frequent change of remedies. In this class of it is especially necessary that we should not only remove the secondary the diseased action, but also correct, as far as possible, the morbid action t organs, and relieve the kidneys by the supplementary function imposed em. The supplementary actions of the skin and gastro-intestinal mem- e of the most important character, and the physician should be careful lest con- and coma, and even death may follow the sudden and injudicious arrest of the and diarrhœa, by which the constituents of the urine are eliminated and of the system. It should be borne in mind also that the effusions in diseases of eys are not simple in their character as in cardiac and hepatic dropsy, but they rea and other constituents of the urine; and the very act of effusion may be a f purification of the blood. Hence even bandages to the lower extremities e applied with caution or wholly abandoned, as tending to throw the effusion portant internal organs; and for the same reason, the recumbent position ot be retained too long, and the patient should take moderate exercise, as by ns the internal organs, and especially the kidneys, are relieved, to a certain rom the dropsical effusion.

e skin and even the lungs may act as supplementary organs to the kidneys, *Pulse, Respiration and Temperature, and amounts and Sp. Gr. in Urine in Case of John Crowley—Bright's Disease.*

DATE.	HOUR OF DAY.	PULSE.	RESPIRATION..	TEMPERATURE OF AXILLA...	CHARACTER OF URINE.			
					Amount of Urine in 24 hours in f. ozs.	Sp. Gr. of Urine.	Albumen and Uniary Casts.	
1869.							Albumen.	Casts.
Dec. 9..........	9 A M	72	18	98.8	88	1009	1-5	do
9..........	7 P M	73	18	101.4	...	......		
10..........	9 A M	73	18	99.4	88	1009	1-5	do
10..........	7 P M	73	18	99.4	...	......		
11..........	9 A M	70	17	99.4	88	1009	1-6	do
11..........	7 P M	91	18	98.8	...	......		
12..........	9 A M	75	20	99.4	111	1008	1-6	do
12..........	7 P M	88	20	100.2	...	......		
13..........	9 A M	76	19	98.5	103	1008	1-6	do
17..........	9 A M	72	17	100.	65	......	1-4	do
17..........	7 P M	...	...	100.8	...	1008		
18..........	9 A M	72	17	99.	100	......	1-4	do
18..........	7 P M	72	17	100.8	...	1008		
20..........	9 A M	80	17	99.4	75	......	1-4	do
20..........	7 P M	...	...	100.5	...	1008		
21..........	9 A M	...	...	99.5	75	......	1-3	do
21..........	7 P M	...	...	100.	...	1008		
22..........	9 A M	...	...	99.5	68	......	1-2	do
22..........	7 P M	...	...	99.7	...	1008		
23..........	9 A M	...	...	99.	65	......	1-2	do
23..........	7 P M	...	...	99.	...	1008		
27..........	9 A M	...	...	99.8	70	......	1-2	do
27..........	7 P M	100	20	100.	...	1008		
28..........	9 A M	...	...	100.	50	......	1-2	do
28..........	7 P M	90	...	100.	...	1008		
29..........	9 A M	...	...	100.5	50	......	2-3	do
29..........	7 P M	95	...	99.9	...	1008		
30..........	9 A M	...	...	101.	42	......	2-3	do
30..........	7 P M	90	...	101.	...	1008		
31..........	9 A M	...	...	101.	32	......	2-3	do
31..........	7 P M	90	...	101.	...	1008		
1870.						......		
Jan. 3..........	9 A M	...	...	......	33	1008	2-3	do
3..........	7 P M	90	...	99.2	...	......		
4..........	9 A M	...	...	......	23	1008	1-2	do
4..........	7 P M	83	...	99.2	...	......		
5..........	9 A M	...	...	......	38	1008	1-2	do
5..........	7 P M	80	...	99.5	...	......		
6..........	9 A M	...	...	......	38	1008	1-2	do
6..........	7 P M	78	...	99.5	...	......		

DATE.	HOUR OF DAY.	PULSE.	RESPIRATION..	TEMPERATURE OF AXILLA...	CHARACTER OF URINE.			
					Amount of Urine in 24 hours in f. ozs.	Sp. Gr. of Urine.	Albumen.	
1870.							Albumen.	Casts.
Jan. 7..........	9 A M	...	...	99.5	50	......	1-4	do.
8..........	9 A M	72	...	99.6	58	......	1-4	do.
10..........	9 A M	72	...	99.5	67	......	1-4	do.
13..........	9 A M	80	...	96.5	58	......	1-2	do.
24..........	9 A M	64	17	100.	29	1010	1-4	do.
24..........	6 P M	74	18	100.	...	......		
25..........	9 A M	62	15	100.	31	1908	1-4	do.
25..........	6 P M	90	20	100.	...	......		
26..........	9 A M	80	18	99.	37	1010	1-3	do.
....	6 P M	64	18	99.	...	......		
27..........	9 A M	72	19	99.	36	1010	1-3	do.
27..........	6 P M	84	19	100.	...	......		
28..........	9 A M	96	20	100.	40	1010	1-2	do.
28..........	6 P M	80	19	100.	...	......		
29..........	9 A M	75	18	100.	34	1010	1-2	do.
29..........	6 P M	80	19	100.	...	......		
30..........	9 A M	84	20	100.	26	1010	1-2	do.
31..........	9 A M	90	22	100.	30	1010	1-2	do.
Feb. 1..........	9 A M	84	23	99.	29	1010	1-2	do.
....	6 P M	80	19	101.	...	......		
2..........	A M	84	23	99.	30	1010	1-2	do.
2..........	6 P M	84	21	100.	...	......		
3..........	9 A M	84	22	99.	30	1010	1-2	do.
3..........	6 P M	80	20	100.	...	......		
4..........	9 A M	90	22	99.	36	1010	1-2	do.
4..........	6 P M	90	24	99.	...	......		
5..........	9 A M	90	24	100.	32	1010	1-2	do.
5..........	7 P M	90	23	101.	...	......		
6..........	9 A M	84	22	101.	34	1008	1-2	do.
6..........	7 P M	85	22	100.	...	......		
7..........	9 A M	90	24	102.	34	1010	1-2	do.
7..........	6 P M	100	23	100	...	......		
8..........	9 A M	115	30	104.	...	......		
8..........	6 P M	98	22	100.	...	......		
9..........	9 A M	102	23	99.	...	......		
9..........	6 P M	102	26	105.	...	......		
10..........	9 A M	84	23	99.	...	......		
10..........	7 P M	86	24	100.	...	......		
11..........	9 A M	96	28	......	...	......		
11..........	6 P M	90	26	......	...	......		

ttention should be paid to the clothing and to the surrounding temperature and
tric condition of the atmosphere.

mount and character of the urinary secretion may also be greatly influenced by
is well established that an exclusive diet of meat greatly increases the nitrogen-
ents, (urea and uric acid, etc.) of the urine, whilst an exclusive farinaceous
tly diminishes these constituents of the urinary excretion. The importance of
to the diet is placed in a clear light, when the relations of the retained urea
rvous phenomena and convulsions characteristic of Bright's Disease are con-

olic stimulants, and stimulating diuretics not only induce the disease, but when
in, they aggravate the symptoms and accelerate its progress. Alcoholic stim-
ould be withdrawn at the earliest possible moment.

acute form of Bright's Disease dependent upon the action of cold or the poison
t fever, the bowels should be kept freely open by saline purgatives, and the
on of the kidneys relieved as far as possible, by cut cups and leeches over the
f the kidneys, and the function of the skin should be freely excited by the
th, hot bath, vapor bath, and warm clothing. As purgatives, the compound
wder, or epsom salts, or a combination of carbonate of magnesia and epsom salts
carb. gr. vi; magnes. sulph. one drachm to one and a half drachms; aquæ menth.
and a half fluidounces; mix; administer every four or six hours), may be
. As a general rule, mercurials should be avoided in both acute and chronic
Disease.

iet should be of the severest antiphlogistic character, composed chiefly of fari-
substances; for in the acute form, the blood is not sufficiently deteriorated to
rich nitrogenized food, and but little diet is wanted.

lating diuretics are contra-indicated, and in order to excite the action of the kid-
to promote also the absorption of the dropsical effusion, such diuretics as the
of Ammonia, and Bitartrate and Tartrate of Potassa, and the Seltzer and Vichy
ay be employed.

convulsions and coma supervene in consequence of the retention of the urea in
d, local depletion by leeches and cupping to the temples, and in some cases gen-
d-letting, and blisters to the shaven scalp, are in conjunction with the hot bath
purgation with elaterium and brisk hydragogue cathartics the main measures
stituted.

treatment of the chronic form of Bright's Disease, the patient should be
to dress warm, with flannel next the skin, he should occupy a dry and warm
, and avoid all changes of the temperature, and all exposure to the night air, or
damp weather. When the circumstances will permit of it, the patient should
to a warm, moist climate, for by this change, not only is the function of the skin
to increased activity, but the changes of the body are less, and the amount of
rformed by the kidneys necessarily diminished.

to the constant loss of albumen from the blood, as well as to the poisonous
the constituents of the urine, it is necessary that the diet should be more
s than in the acute form.

erman physicians have claimed important results in the treatment of chronic
Disease, by confining the patients to an exclusive diet of milk, without any
whatever. In this plan of treatment, from five to six pints of *good undiluted*
lk were administered daily; and some of the patients, who prior to the treat-
d been in the most wretched condition, got rid of their dropsy, recovered an
ce of health, and regained so much of their strength, as to be able to resume
siness and even to perform hard labor.

the active measures should be excluded blood-letting and mercurials; and
for the relief of dropsy especially, and the elimination of the deleterious
from the blood, should be placed on the judicious establishment of diaphoresis,
and purgation.

One of the most efficient modes of establishing active diaphoresis as previously indicated, is by the daily use of the hot bath, followed by sweating for one or two hours in woollen blankets.

Stimulating diuretics should be avoided on account of their irritating action on the kidneys; such diuretics as the Tartrate and Bitartrate of Potassa, may be employed persistently for a great length of time, and as far as my experience extends, if administered in a manner previously recommended, their action is always attended with benefit and relief of the dropsical symptoms.

Of course, in those cases where the stomach is so irritable that neither the Cream of Tartar nor any other diuretic is borne, there is little or no chance of recovery.

The dropsy may also be controlled, and to a certain extent, relieved, by the judicious employment of such purgatives as Elaterium, Colocynth, Compound Powder of Jalap, Cream of Tartar and Sulphur, Epsom Salts and Glauber Salts.

It should be borne in mind that the duration and results of Bright's Disease, depend upon the extent to which the kidneys have been altered; the most frequent termination being death, caused either directly by the affection of the kidney, or by intercurrent inflammation; complete recovery may take place, but it is very rare; some cases run their entire course in a period of from six weeks to three months, and in others the malady continues for years. Although in most cases, a cure may not be effected, the physician may accomplish much good by relieving the symptoms and prolonging life.

It is important therefore in a disease of such a chronic nature, that the continual tendency to the deterioration of the blood, should be counteracted by the use of Iron and Quinine, and nutritious diet.

OBSERVATIONS

ON

DISEASES OF THE RESPIRATORY SYSTEM.

INVESTIGATIONS

ON THE PREVALENCE AND FATALITY

OF

PNEUMONIA

IN THE CONFEDERATE ARMY, DURING THE AMERICAN CIVIL WAR—1861-1865:

WITH PRACTICAL OBSERVATIONS ON THE

RELATIVE VALUE OF THE VARIOUS MODES OF TREATING PNEUMONIA.

INVESTIGATIONS ON THE PREVALENCE AND FATALITY OF PNEUMONIA IN THE CONFEDERATE ARMY DURING THE AMERICAN CIVIL WAR OF 1861-1865: WITH PRACTICAL OBSERVATIONS ON THE RELATIVE VALUE OF THE DIFFERENT MODES OF TREATING PNEUMONIA.

CHAPTER XVI.

ON THE PREVALENCE AND FATALITY OF PNEUMONIA AND OF TYPHOID FEVER IN THE CONFEDERATE ARMY DURING THE WAR OF 1861-1865.

Importance of Pneumonia in view of its Prevalence and Fatality. Table giving Mean Strength, the Total of Sick and Wounded, the Cases of Pneumonia, and the Percentage of Pneumonia in Mean Strength, etc., in the Confederate Army during Nineteen Months, 1862–1863. Analysis of this Table. Cases most Numerous in the Winter and Spring Months. Table illustrating the Prevalence of Pneumonia in the Armies serving in Different Sections of the Confederate States. Cases in Virginia; in the Army of the West, etc. Cases of, and Deaths from, Pneumonia, Typhoid Fever, and other Diseases in the General Hospitals of the Army of the Potomac, Northern Virginia and other Hospitals, during Fifteen Months, in 1862–1863. Common Continued and Typhoid Fever identical. Percentage of Deaths from Pneumonia. Fatality from Pneumonia and Typhoid Fever. Fatality from other Diseases. Cases of, and Deaths from, Typhoid Fever. Pneumonia, and some other Diseases in the General Hospitals in and around Richmond, during Seven Months, in 1862–63. Cases of, and Deaths from, Pneumonia, Typhoid Fever and several other Diseases, in the General Hospitals in Virginia. Cases of, and Deaths from, Pneumonia and some other Diseases, in the General Hospital at Charlottesville, Va., during Twenty-six Months, from July, 1861 to August, 1863. Fatality in Hospitals at Savannah, of Pneumonia and Typhoid Fever. Table showing the Numerical Relations of, Cases of, and Deaths from, Typhoid Fever and Pneumonia, in the General Hospitals in Virginia and Georgia. Progressive Diminution of the Prevalence of Typhoid Fever during the War. Table illustrating the Numerical Relations of Pneumonia and Typhoid Fever in the Confederate Armies during Nineteen Months, 1862–63. Cases and Deaths from all Causes, and Cases of, and Deaths from, Pneumonia and Typhoid Fever in the General Hospitals of Charlottesville and Staunton, Va.

THE prevalence of Pneumonia in the Confederate Army, and the high rate of mortality amongst the cases treated in the field and in the general hospitals, invested this disease with peculiar interest and importance; and the writer urged upon the Surgeon-General the importance of a thorough examination of the relative value of the different modes of treatment employed by the Confederate Surgeons. The following pages contain facts relating to Pneumonia, which were contained in a report to the Surgeon-General during the progress of the recent civil war:

Table giving the Mean Strength, Officers and Men, the Total Sick and Wounded, and the Total Cases of Pneumonia, and the Percentage of Pneumonia in Mean Strength, and in Sick and Wounded in the Confederate Army during Nineteen Months, January, 1862, *to July,* 1863, *Consolidated from Field and Hospital Reports, by Joseph Jones, M. D., Surgeon Provisional Army C. S. A.*

MONTH AND YEAR.	FIELD REPORTS.						HOSPITAL REPORTS.			
	Mean strength officers and men.	Total sick and wounded entered during month.	Aggregate sick and wounded during month.	Cases of Pneumonia.	Per cent. of cases of Pneumonia in mean strength.	Per cent. of cases of Pneumonia in sick and wounded during month.	Total sick entered during month.	Aggregate sick and wounded.	Cases of Pneumonia.	Per cent. of cases of Pneumonia in full. sick and wounded during month.
1862.										
January	232,138	90,757	115,416	3,960	1.70	4.35	3,292	5,727	337	10.24
February	219,069	71,672	96,463	2,041	0.93	2.84	2,472	4,798	365	10.72
March	165,047	50,385	63,387	1,849	1.12	3.67	2,341	3,999	408	17.00
April	58,304	23,243	27,559	891	0.06	3.83	2,543	6,784	540	21.23
May	58,690	25.985	30,491	360	0.61	1.38	9.700	14,067	656	6.76
June	136,362	78,583	94,487	881	0.65	1.12	16,605	26,120	812	4.89
July	79,999	41,700	55,997	826	1.03	1.98	18,918	28,437	491	2.59
August	113,407	50,987	64,436	430	0.379	0.84	21,546	31,662	303	1.46
September	125,408	42,450	51,432	179	0.142	0.421	46,733	55,726	473	1.01
October	156,734	48,605	59,841	384	0.245	0.79	39,170	53,970	465	1.18
November	270,480	71,328	90,472	2,282	0.84	3.20	44,890	50,164	2,587	5.76
December	172,800	67,461	85,769	2,985	1.72	4.42	29,032	44,282	1,811	6.23
1863.										
January	192,776	76,620	96,053	2,676	1.38	3.49	12,542	27,784	1,117	8.90
February	215,458	60,135	80,889	1,997	0.92	3.32	13,378	28,652	963	7.19
March	313,848	92,788	117,171	2,816	0.89	3.03	12,809	24,812	1,086	8.48
April	190,518	60,407	74,806	1,779	0.93	2.94	14,884	26,628	1,252	8.41
May	163,711	49,589	63,211	1,593	0.97	3.20	41,889	57,822	1,130	2.69
June	107,153	33,805	43,114	267	0.249	0.79	27,389	46,702	483	1.76
July	72,396	20,849	24,807	77	0.106	0.37	37,073	55,708	283	0.98
Total	160,231	1,057,349		28,273			397,406		15542	

From this table it appears that in the Confederate Army, with a mean monthly strength of 160,231 officers and men, 1,057,349 cases of disease and wounds were entered upon the field reports during a period of nineteen months, (January, 1862 to July, 1863, inclusive); and of this number Pneumonia constituted 28,273.

Seventeen and six tenths per cent. of the mean strength of the army, on an average, suffered with Pneumonia during a period of nineteen months; and this disease constituted two and seven tenths per cent. of all cases of disease and wounds entered upon the field reports.

During this period of nineteen months, 397,406 cases of disease and wounds were entered upon the Hospital Reports, and of this number 15,542 were recorded as Pneumonia; and this disease, therefore, constituted 3.15 per cent. of all the cases of disease and wounds entered upon the Hospital Reports.

The cases of Pneumonia entered upon the Field and Hospital Reports were relatively most numerous as compared to the mean strength and the total sick and wounded during the months of December, January, February, March and April; whilst the smallest number of cases were recorded upon the field reports and transferred to the general hospitals during the months of August, September and October. As a general rule the cases of Pneumonia diminished, as the temperature became more elevated, and the vicissitudes of the season less marked. The month of July, 1862, is an apparent exception, but it will be observed that the number transferred to the general hospitals was very small, only 491, or 2.59 per cent. of all diseases and wounds; and during the same month, in 1863, the number of cases of Pneumonia is smaller relatively than in any other month, being only 0.106 per cent. of the mean strength, and 0.98 per cent. of the sick and wounded transferred to the general hospital.

The disease, therefore, would appear to depend in large measure upon seasons; or, in other words, upon the effects of exposure to cold and wet, and to marked vicissitudes of heat and moisture. The following tables present data for the investigation of the effects of elevation, geographical position and temperature upon the prevalence of Pneumonia:

Tables illustrating the Prevalence of Pneumonia in the Armies serving in Different Sections of the Confederate States, giving Mean Strength, Cases of Wounds and Diseases entered during each Month, and Cases and Deaths of Pneumonia, (the Deaths given only when the records are complete), Consolidated from Field and Hospital Records on File in the Surgeon-General's Office, at Richmond, by Joseph Jones, M. D., Surgeon P. A. C. S.

CONFEDERATE FORCES SERVING IN VIRGINIA AND NORTH CAROLINA.

MONTH AND YEAR.	FIELD REPORTS.			HOSPITAL REPORTS.	
	Mean Strength, Officers and Men.	Total Sick and Wounded entered during Month.	Total Cases Pneumonia.	Total Sick and Wounded entered during Month.	Total Cases Pneumonia.
1862.					
January	187,951	73,740	3,247	1,690	367
February	181,309	60,413	1,617	1,508	220
March	136,970	42,027	1,516	1,302	187
April	26,807	10,419	470	——	—
May	27,422	11,393	205	6,048	376
June	60,642	29,011	246	8,811	310
July	32,298	12,863	203	9,446	177
August	50,390	17,349	94	17,318	231
September	82,406	25,037	95	33,476	165
October	107,519	29,286	227	29,702	256
November	148,864	32,141	788	30,724	1,422
December	33.568	7,503	185	26,522	1,649
1863.					
January	44,258	13,144	307	11,142	990
February	59.293	10,937	337	11,969	880
March	150.362	29,710	1,094	11,051	940
April	62,089	10, 264	264	12,893	1,079
May	45.196	8,903	130	33,964	856
June	41,756	9,672	68	24,318	418
July	39,432	9,355	36	32,052	220
Total	79,396	443,167	11,025	303.886	10,743

In the Confederate forces serving in Virginia (chiefly in this State) and North Carolina, with a monthly mean strength of 79,396, during a period of nineteen months, 443,167 cases of disease and wounds were entered upon the field reports, and of this number pneumonia constituted 11,025; that is on an average during this period, 13.88 per cent. of the mean strength was affected with pneumonia, and this disease constituted 2,48 per cent. of all cases entered upon the field reports. During the same period 303,886 sick and wounded were entered upon the hospital reports, and of this number, 10,743 or 3.53 per cent. were recorded as pneumonia.

In the army of the West, afterwards called the army of Tennessee, which operated chiefly in the elevated regions of Tennessee, Kentucky, Alabama, and Mississippi, with a monthly mean strength of 40,273 during a period of twelve months, 226,721 cases of disease and wounds were entered upon the field reports (some of the hospital reports appear to have been lost,) and of this number, pneumonia constituted 6974; that is, on an average during this period, extending from the first of June 1862, to the 31st of May, 1863, 17.31 per cent. of the mean strength were attacked by pneumonia, and this disease constituted 3.07 per cent. of all cases entered upon the field reports; during the period of twelve months (April 1st to October 31st; May 1st to July 31st,) in the hospitals of the West, located in Tennessee, Upper Georgia, and Alabama. 54,672 sick and wounded were entered upon the reports, and of this number 2957, or 5.43 per cent., were recorded as pneumonia.

The proportion of cases of pneumonia appears, therefore, to have been greater in the elevated regions of the West, than in Virginia. It is probable that the modifying effects of the ocean upon the climate of Virginia, was the chief cause of this difference. On the other hand, in an army of 25,670 men (average monthly strength,) serving along the low hot coast of South Carolina, Georgia, and Florida, during a period of nineteen months, only 8.25 per cent. of the entire command (mean strength) were attacked by pneumonia; and this disease constituted only 1.35 per cent. of the total number of diseases and wounds entered upon the field reports.

The percentage of the mean strength attacked upon the Gulf coast, was somewhat higher even than in the army of Tennessee; the ratio of the cases of pneumonia being 17.22 per cent. of the monthly mean strength. It is to be observed however, that the force serving in and around Mobile, on the Gulf coast, was comparatively small, being only 6752 officers and men, and the statistics embrace both the field and hospital reports. This confusion, therefore, of the field and general hospital reports renders it impossible to institute a just comparison with the armies of Virginia, Tennessee, and South Carolina, and Georgia. It appears also that the troops of the Gulf coast were subjected to a more moist and malarious climate than the mass of the troops serving in South Carolina, Georgia and Florida. A large portion of the troops serving along the Atlantic coast, in the latter department, were encamped in dry, sandy, pine-barren, healthy locations, which, although elevated but a few feet above the level of the ocean, are, nevertheless, remarkably free from diseases of the pulmonary organs of a serious character.

It appears, therefore, from these statistics, that pneumonia prevailed to the greatest extent in the more elevated and northern regions of the Southern Confederacy, and in the armies which were subjected to the severest labors, privations, and exposures.

Pneumonia not only prevailed to a considerable extent amongst the Confederate troops, but it was also one of the most fatal of diseases.

Thus in a command with a monthly mean strength of 25,670 men, serving in the department of South Carolina, Georgia and Florida, during a period of nineteen months (January, 1862, July 1863,) 2220 cases of pneumonia, with 127 deaths, were entered upon the field reports, and 1786 cases, with 370 deaths upon the hospital reports. As the cases were in most instances, first entered upon the field reports, and then transferred to the general hospitals, we will approximate more nearly to the truth, by assuming that the 2220 cases of pneumonia entered upon the field reports, include those also transferred to the general hospitals, and the mortality of the cases treated in general hospitals, should be added to the mortality of the cases treated in the field; thus giving a mortality of 497 in 2220 cases of pneumonia. According to this calculation, 22.3 per cent. of the cases of pneumonia terminated fatally, or one death occurred in 4.4 cases.

In the Confederate army serving on the Gulf of Mexico, in and around Mobile, with a mean monthly strength of 6752, the cases of pneumonia numbered 1161, and the deaths from this disease 151, during a period of eighteen months; or one death in 7.6 cases of pneumonia.

In the army of Tennessee, during a period of fourteen months 8272 cases of pneumonia were recorded, with 1291 deaths; the ratio of deaths, from this disease, being 15.5 per cent., or one death in 6.4 cases. The hospital reports gave a still higher mortality, namely 18.2 per cent., or one death in 5.4 cases.

Upon the field reports of General T. J. (Stonewall) Jackson's army, serving in the Valley of Virginia, during a period of ten months, with an average monthly mean strength of 15,562 officers and men, 1034 cases of pneumonia were reported. During this short period 6.6 per cent. of the mean strength were affected with this disease. The number of deaths entered upon the field reports of General "Stonewall" Jackson's army, was only 50, or 4.8 per cent. of the cases. The returns of deaths were incomplete; it was also true that the cases of pneumonia in this active and fighting army, were in most cases transferred to the general hospitals, and chiefly to the large general hospital at Staunton. The statistics of the Staunton general hospital furnish the most correct data for an estimate of the mortality of pneumonia amongst the forces serving in the Valley of Virginia, throughout the war, under Generals Jackson and Early. During a period of forty-four months, July, 1861 to February, 1865, in the General Hospital at Staunton, Virginia, 833 cases of pneumonia were treated, with 191 deaths. In this large and well-conducted hospital22.9 per cent., (or one death in 4.3 cases,) of the cases of pneumonia terminated fatally. A portion of this mortality, as well as of the mortality in typhoid fever and gunshot wounds, was attributable to the previous exposures and fatigue of the sick in transportation from a distance, during the active operations of the Confederate forces.

The statistics of the general hospitals of Virginia, exclusive of the hospitals in and around Richmond, possess great interest, as furnishing the most reliable data for the determination of the rate of mortality in pneumonia. During a period of fourteen months 4864 cases of pneumonia were entered upon these hospital reports, with a mortality of 1261; the ratio of deaths amongst this large number of cases of pneumonia, treated in some of the largest and best conducted hospitals in the Southern Confederacy was 25.9 per cent., or one death in 3.8 cases.

The following statistics will serve to illustrate the relative mortality from pneumonia, and several of the more important diseases in Confederate hospitals.

Cases and Deaths from Pneumonia, Typhoid Fever, and other Diseases, in the General Hospitals of the Army of the Potomac and Northern Virginia, formerly under the supervision of Surgeon J. H. Williams, Medical Director, including the Confederate Hospitals at Manassas Junction, Front Royal, Warrenton, Warm Springs, Md., Jackson, Leesburg, Culpepper Court-House, Orange Court-House, Gordonsville, Charlottesville, Charlotte, Danville, Farmville, Liberty, Standardsville, Petersburg, and Staunton, during a period of fifteen months, January, 1862, to March, 1863, consolidated from original reports on file in the Surgeon-General's office in Richmond, Va., by Joseph Jones, M. D., Surgeon P. A. C. S.

MONTH AND YEAR.	TYPHOID FEVER.		COMMON CONTINUED FEVER.		REMITTENT FEVER.		CONGESTIVE FEVER.		INTERMITTENT FEVER.		MEASLES.		DIARRHŒA AND DYSENTERY.		PNEUMONIA.		GUNSHOT WOUNDS.		Total from all Diseases and Causes during month.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
1862.																				
January	168	70	45	...	88	2	2	1	40	...	19	1	130	7	367	127	19	6	*4,011	244
February	168	34	11	...	49	...	...	...	47	...	2	...	250	6	220	79	17	1	1,508	144
March	89	40	10	...	26	...	...	...	47	...	4	...	263	1	187	59	30	...	1,302	122
April	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
May	239	93	83	...	84	...	...	...	228	...	453	24	994	26	376	128	157	2	6,048	326
June	369	109	125	...	279	3	2	2	384	...	593	36	1,919	59	310	74	795	26	8,811	405
July	693	256	190	...	797	...	1	...	410	...	183	7	1,769	75	177	48	966	24	9,446	556
August	852	332	184	...	1,296	29	5	...	1,440	...	167	4	2,304	66	231	17	1,431	59	17,318	635
September	461	136	196	...	399	6	3	...	474	...	186	11	1,692	65	69	10	956	238	18,055	560
October	407	102	123	...	198	9	6	...	360	...	89	5	906	68	68	16	1,880	84	8,255	378
November	376	156	96	...	220	2	6	...	988	...	113	3	1,808	57	816	153	840	23	14,131	510
December	159	80	54	...	114	...	3	...	325	...	57	...	707	45	581	156	1,400	21	8,113	451
1863.																				
January	218	93	106	...	92	3	1	...	247	...	50	2	596	40	438	182	511	14	5,557	470
February	244	60	144	.....	87	2	2	...	243	...	40	3	450	49	419	113	345	4	4,792	380
March	306	58	129	.....	91	...	17	4	179	...	60	6	692	23	515	99	440	14	5,567	326
Totals	4,749	1,619	1,496	...	3,820	56	...	...	...	...	...	...	14,470	587	4,774	1,261	9,796	516	113,914	5,516

* This number (4011) represents the aggregate number of cases treated in the hospitals during this month. The number received during January, was 1601, and the number remaining from December, 1861, 2520.

From the preceding table we gather that during this period of fifteen months, one hundred and thirteen thousand nine hundred and fourteen (113,914) cases of various diseases and gunshot wounds were treated in the hospitals of Virginia, exclusive of the hospitals in and around Richmond; out of this number of cases, five thousand five hundred and sixteen (5516) proved fatal.

The ratio of deaths from all causes to the entire number of cases treated, was 4.85 per cent., or one death in every 20.65 cases.

The deaths from common continued fever are here included under the head of typhoid fever. After a careful examination of many cases registered as common continued fever, and after conferences upon this subject with numerous surgeons in Virginia, I have been convinced that the great majority of the cases reported as common continued fever are nothing more than cases of typhoid fever. As the cases recorded as common continued fever amount to near one-third the number of typhoid fever, and as the vast majority of the former should have been classed as the latter, the most accurate calculation is that which combines the two classes together. The ratio of deaths to the cases of typhoid fever and common continued fever was 25.92 per cent., or one death from typhoid and continued fever in 3.85 cases. The ratio of deaths from typhoid and common continued fever, to the entire number of deaths from all causes, is 29.35 per cent., or one death from these diseases in 3.4 deaths from all causes. Whilst on the other hand the ratio of cases of typhoid and common continued fever to the entire number of cases treated is 5.48 per cent., or one case of these diseases in 18.25 cases of all diseases.

A fraction more than one fourth the cases of pneumonia terminated fatally, or more exactly 22.86 per cent., or one death in 3.78 cases of pneumonia. The ratio of the deaths from pneumonia, to the deaths from all causes, was 22.86 per cent., or one death from pneumonia in every 4.37 deaths from all causes; whilst on the other hand the cases of pneumonia amounted to only 4.16 per cent. of the entire number of cases.

Typhoid fever, common continued fever, and pneumonia together, caused two thousand eight hundred and eighty deaths, out of five thousand five hundred and sixteen deaths from all diseases; that is, a little more than one half the deaths from all causes were due to typhoid fever and pneumonia, or more exactly 52.39 per cent.

12.7 per cent. of the cases were classed under the head of chronic and acute diarrhœa and dysentery, whilst the mortality from these diseases was 4.05 per cent. of the cases of diarrhœa and dysentery, and 10.51 per cent. of the entire number of deaths from all causes.

Only one case out of 11.6 of all diseases was due directly to the casualties of war; that is, the cases of gunshot wounds were only 8.59 per cent. of the entire number of cases. The mortality from gunshot wounds was a little less than one tenth of the entire number of deaths from all causes, or more exactly 9.35 per cent., or one death from gunshot wounds in every 10.69 deaths.

The ratio of deaths from all causes to the entire number of cases treated in the hospitals in and around Richmond, Va., during a period of seven months, September, 1862, to March, 1863, was 4.11 per cent., or one death in 24.37 cases.

The record of the deaths, during several months, was incomplete. In this table, as in the preceding and succeeding tables, I determined the number of deaths from various diseases from the long rolls in which the name of the deceased soldier, together with the disease causing death, was recorded, without any classification as to the disease. In several of the monthly reports, large portions of these rolls were absent from the consolidated medical director's reports. The labor necessary to the classification of the diseases causing several thousand deaths was very great. In this table as in the previous one, the deaths from common continued fever are included under the head of typhoid fever. During six months, September, October, November, 1862, January, February, and March, 1863, two thousand seven hundred and forty-eight (2748) cases were recorded of typhoid and common continued fever, and during the same period seven hundred and twenty-three deaths from these diseases. Therefore more than one-

Cases and Deaths from Pneumonia, Typhoid Fever, and other Diseases, in the General Hospitals of the Army of the Potomac and Northern Virginia, formerly under the supervision of Surgeon J. H. Williams, Medical Director, including the Confederate Hospitals at Manassas Junction, Front Royal, Warrenton, Warm Springs, Md., Jackson, Leesburg, Culpepper Court-House, Orange Court-House, Gordonsville, Charlottesville, Charlotte, Danville, Farmville, Liberty, Standardsville, Petersburg, and Staunton, during a period of fifteen months, January, 1862, to March, 1863, consolidated from original reports on file in the Surgeon-General's office in Richmond, Va., by Joseph Jones, M. D., Surgeon P. A. C. S.

Month and Year.	Typhoid Fever.		Common Continued Fever.		Remittent Fever.		Congestive Fever.		Intermittent Fever.		Measles.		Diarrhœa and Dysentery.		Pneumonia.		Gunshot Wounds.		Total from all Diseases and Causes during month.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
1862.																				
January	168	70	45	...	88	2	2	1	40	...	19	1	130	7	367	127	19	6	*4,011	244
February	168	34	11	...	49	...	...	...	47	...	2	...	250	6	220	79	17	1	1,508	144
March	89	40	10	...	26	...	...	...	47	...	4	...	263	1	187	59	30	...	1,302	122
April	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
May	239	93	83	...	84	...	...	...	228	...	453	24	994	26	376	128	157	2	6,048	326
June	369	109	125	...	279	3	2	2	384	...	593	36	1,919	59	310	74	795	26	8,811	405
July	693	256	190	...	797	...	1	...	410	...	183	7	1,769	75	177	48	966	24	9,446	556
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	4,740	1,619	1,406	...	3,820	56	...	...	...	...	...	...	14,470	587	4,774	1,261	9,796	516	113,914	5,516

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deaths from common continued fever are here included under the head of typhoid After a careful examination of many cases registered as common continued nd after conferences npon this subject with numerous surgeons in Virginia, I en convinced that the great majority of the cases reported as common continued re nothing more than cases of typhoid fever. As the cases recorded as common ed fever amount to near one-third the number of typhoid fever, and as the vast y of the former should have been classed as the latter, the most accurate calcu- s that which combines the two classes together. The ratio of deaths to the f typhoid fever and common continued fever was 25.92 per.cent., or one death phoid and continued fever in 3.85 cases. The ratio of deaths from typhoid and n continued fever, to the entire number of deaths from all causes, is 29.35 per r one death from these diseases in 3.4 deaths from all causes. Whilst on the and the ratio of cases of typhoid and common continued fever to the entire of cases treated is 5.48 per cent., or one case of these diseases in 18.25 cases of ses.

ction more than one fourth the cases of pneumonia terminated fatally, or more 22.86 per cent., or one death in 3.78 cases of pneumonia. The ratio of the rom pneumonia, to the deaths from all causes, was 22.86 per cent., or one death eumonia in every 4.37 deaths from all causes; whilst on the other hand the pneumonia amounted to only 4.16 per cent. of the entire number of cases.

oid fever, common continued fever, and pneumonia together, caused two thou- ht hundred and eighty deaths, out of five thousand five hundred and sixteen rom all diseases; that is, a little more than one half the deaths from all causes e to typhoid fever and pneumonia, or more exactly 52.39 per cent.

per cent. of the cases were classed under the head of chronic and acute diar- d dysentery, whilst the mortality from these diseases was 4.05 per cent. of the diarrhœa and dysentery, and 10.51 per cent. of the entire number of deaths causes.

one case out of 11.6 of all diseases was due directly to the casualties of war; the cases of gunshot wounds were only 8.59 per cent. of the entire number of The mortality from gunshot wounds was a little less than one tenth of the number of deaths from all causes, or more exactly 9.35 per cent., or one death unshot wounds in every 10.69 deaths.

ratio of deaths from all causes to the entire number of cases treated in the hos- in and around Richmond, Va., during a period of seven months, September, to March, 1863, was 4.11 per cent., or one death in 24.37 cases.

record of the deaths, during several months, was incomplete. In this table, as preceding and succeeding tables, I determined the number of deaths from various es from the long rolls in which the name of the deceased soldier, together with the causing death, was recorded, without any classification as to the disease. In of the monthly reports, large portions of these rolls were absent from the con- ed medical director's reports. The labor necessary to the classification of the es causing several thousand deaths was very great. In this table as in the pre- one, the deaths from common continued fever are included under the head of d fever. During-six months, September, October, November, 1862, January, ary, and March, 1863, two thousand seven hundred snd forty-eight (2748) cases ecorded of typhoid and common continued fever, and during the same period hundred and twenty-three deaths from these diseases. Therefore more than one-

Cases of, and Deaths from, Pneumonia, Typhoid Fever and several other Diseases, in the General Hospitals in Virginia, including those in and around Richmond, Virginia, under the supervision of Surgeon William A. Carrington, Medical Director. Classified and consolidated from Monthly Reports, by Joseph Jones, M. D., Surgeon P. A. C. S.

MONTH AND YEAR.	TYPHOID FEVER.		COMMON CONTINUED FEVER.		REMITTENT FEVER.		CONGESTIVE FEVER.		INTERMITTENT FEVER.		MEASLES.		DIARRHŒA AND DYSENTERY.		PNEUMONIA.		GUNSHOT WOUNDS.		TOTAL FROM ALL DISEASES AND CAUSES.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
1863.																				
April	350	110	71	...	248	...	4	...	382	...	80	...	1,261	...	951	264	1,096	...	*20,784	694
May	589	134	221	...	350	...	6	...	804	...	132	...	3,488	...	767	180	9,722	...	32,112	800
June	471	200	418	...	910	...		...	1,223	....	91	...	4,990	...	406	104	3,660	...	23,217	602
July	522	65	221	...	458	...	8	...	834	...	48	...	4,010	...	220	28	11,334	...	32,052	420
Totals	1,932	509	931	...	1,966	...	8	...	3,143	...		...		...	2,344	576		...	108,165	2,705

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*number represents the aggregate for April, and includes the number received during this month, 10,870, and the number remaining from last report, 9914.

nated fatally, that is, one death occurred in every 3.12 cases of Pneumonia. The ratio of deaths from Pneumonia, to the entire number of deaths from all causes, was 23.84 per cent., or one death from Pneumonia in 4.17 deaths from all causes, Pneumonia included. On the other hand, the cases of Pneumonia were less than one twenty-third of the entire number of cases (4.32 per cent.,) or, more plainly, one case of Pneumonia in 23.13 cases of all diseases, Pneumonia included.

Typhoid Fever and Pneumonia, together, caused 519 deaths out of 868 deaths from all causes, these diseases included. That is, Typhoid Fever and Pneumonia caused more than one-half, or 59.9 per cent. of the deaths from all causes, gunshot wounds included; or, one death from Pneumonia and Typhoid Fever occurred in every 1.67 deaths. On the other hand, the cases of Pneumonia and Typhoid Fever, were only 12.98 per cent. of the entire cases. And the ratio of deaths from all causes, to the entire number of cases, was 5.79 per cent., or one death in 17.24 cases of all diseases treated.

The largest number of cases of Typhoid Fever occurred in July, August, September and October, 1861, and during the first thirteen months (July, 1861 to July, 1863, inclusive), 1094 cases of Typhoid Fever entered the hospital, whilst during the last thirteen months (August, 1862 to August, 1863, inclusive), only about one-fifth the number of cases of Typhoid Fever entered, or more exactly, 203 cases. During the first thirteen months, 253 deaths from typhoid fever occurred; whilst during the last thirteen months only 60 deaths, or not quite one-fourth the number of the first thirteen months. During the first thirteen months, 1040 cases of measles were entered; whilst during the last thirteen months, only 20 cases of measles were recorded. This disease, therefore, like typhoid fever, decreased as the war advanced. As a general rule, mankind are afflicted with these diseases but once during a lifetime, and during this war, both diseases appear to have been intimately connected in their origin and spread with the crowding together of the soldiers; whilst they are, without doubt, due to distinct and wholly different poisons, still they have in this war been associated, to a certain extent, in the time and circumstances of their origin and diffusion. We observe no such law governing pneumonia. This disease was most abundant during the cold, wet, and changeable weather of winter and spring, and there was no marked diminution of the disease as the war progressed, beyond that incident to the hardening and strengthening of the troops under exposure and fatigue.

The cases of gunshot wounds were 18.99 per cent. of the entire number of cases; and the deaths from gunshot wounds were 17.62 per cent. of the entire number of deaths, or, 5.44 per cent. of the entire number of cases of gunshot wounds treated.

In instituting comparisons between the statistics of the General Hospital of Charlottesville, and those of other portions of the Confederate States, it should be borne in mind, that the General Hospital of Charlottesville, was one of the nearest hospitals to the largest and most active army in the Southern Confederacy. The severest cases of disease were, as a general rule, left at this and other hospitals nearest to the scene of active service; whilst the mildest cases were forwarded to the more distant hospitals. It results from these facts, that all things being equal, as to treatment, nourishment, and hygiene, the mortality in a hospital thus situated and supplied with patients must necessarily be heavier than in hospitals connected with armies much smaller and comparatively at rest, where large numbers of the severe cases were treated in the field hospitals.

As high as the preceding rates of mortality in pneumonia and typhoid fever may appear, they are not as high as in some others of the Confederate hospitals. Thus in the two general hospitals of Savannah, Ga., Nos. 1 and 2, the ratio of mortality in these diseases was extraordinarily high. And we are at a loss to account for this high death-rate, from the fact that these hospitals were connected with a comparatively small and inactive army. As the troops serving in and around Savannah were greatly exposed to the influence of malaria, this depressing agent may have influenced, [illegible]rtain extent, the death-rate.

In General Hospital No. 1, Savannah, Ga., during a period of twenty-[illegible] *ses of, and deaths from, Pneumonia, Typhoid Fever, and some other Diseases, in the General Hospital, Charlottesville, Va., during Twenty-six Months, July 1861, to August 1863. Consolidated from the Official Monthly Reports, by Joseph Jones, M. D., Surgeon, P. A. C. S.*

MONTH AND YEAR.	TYPHOID FEVER.		COMMON CONTINUED FEVER.		REMITTENT FEVER.		CONGESTIVE FEVER.		INTERMITTENT FEVER.		MEASLES.		DIARRHŒA AND DYSENTERY.		PNEUMONIA.		GUNSHOT WOUNDS.		Total Diseases and Wounds Entered During Month.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
1861.																				
July	284	75	...	...	35	...	1	...	53	...	656	8	178	6	48	18	300	35	2,608	147
August	74	46	...	...	7	...	..	...	...	...	116	4	16	3	6	10	6	21	329	87
September	150	24	...	...	18	...	1	...	27	...	104	..	43	..	12	2	9	6	511	32
October	195	27	...	...	21	...	..	...	31	...	51	..	31	..	14	2	15	...	556	33
November	100	15	...	....	14	...	..	...	12	...	22	2	31	..	41	7	...	...	448	31
December	63	6	...	....	8	...	1	...	9	...	7	..	19	1	22	3	7	...	329	12
1862.																				
January	30	4	...	...	3	...	..	...	5	...	...	..	18	1	24	15	2	...	226	21
February	34	5	...	....	6	...	..	...	2	...	1	..	66	..	21	...	1	...	300	6
March	14	1	...	....	3	...	..	...	13	...	1	..	56	..	21	4	2	...	290	9
April	60	8	...	....	4	...	..	...	22	...	48	1	61	2	80	25	3	...	539	44
May	32	20	1	1	1	...	..	...	12	...	20	..	67	3	35	36	16	...	429	67
June	23	13	...	....	6	...	..	...	13	...	14	..	95	..	20	12	266	12	754	53
July	33	11	...	...	10	...	..	...	6	...	...	..	73	..	9	3	41	7	337	26
August	19	10	...	...	4	...	..	...	6	...	...	..	45	2	2	...	380	21	682	35
September	7	2	...	...	2	...	..	...	...	...	1	..	9	..	1	...	764	18	886	23
October	5	3	...	....	3	...	..	...	4	...	1	..	12	1	1	1	56	3	340	11
November	21	7	...	....	2	...	..	...	46	...	8	..	54	2	38	15	46	2	916	32
December	21	7	1	....	6	...	..	...	8	...	2	..	45	3	118	27	158	8	993	54
1863.																				
January	16	4	...	...	3	...	.	...	10	...	1	..	42	4	49	11	42	7	601	41
February	12	5	1	...	2	...	..	...	8	...	2	..	35	3	23	7	24	3	312	26
March	6	2	2	...	...	...	..	...	4	...	...	..	27	1	15	6	31	4	198	17
April	3	3	1	...	...	...	..	...	4	...	...	..	21	..	6	8	14	1	124	14
May	15	5	1	...	11	...	..	...	18	...	1	..	115	1	14	2	66	1	572	11
June	14	3	..	...	11	...	..	...	14	...	2	..	100	1	13	2	77	1	417	8
July	11	1	3	...	8	...	..	...	13	...	...	..	49	2	6	...	444	4	821	7
August	55	5	5	...	30	...	..	...	13	...	2	..	51	4	8	1	93	1	449	11
Totals	1,297	312	15	1	118	...	3	...	...	...	1,060	15	...	..	647	207	2,843	153	14,966	868

(December, 1861 to December, 1863, inclusive,) 178 cases of typhoid fever were recorded, with 91 deaths. In this hospital, therefore, more than one-half proved fatal.

The percentage of deaths in the cases of typhoid fever was 51.12; that is, one death occurred in 1.95 cases. Between one-third and one-fourth of the entire deaths from all causes were from typhoid fever, or, more exactly, one death from typhoid fever occurred in every 3.65 deaths; the deaths from typhoid fever were 27 per cent. of the entire deaths from all causes. On the other hand, the cases of typhoid fever were a little less than two and a half per cent. of the entire number of cases of all diseases; or, more exactly, 2.48 per cent of the entire number; or, the ratio of cases of typhoid fever was as 1 to 40.

In the cases of pneumonia, a little over one-third, or one in 3.18, or 31.35 per cent. proved fatal. More than one-third of the entire deaths, from all diseases, were caused by pneumonia; or, one death from pneumonia occurred in every 2.87 deaths, giving 34.83 per cent. of deaths from pneumonia. On the other hand, only a little over five per cent. 5.17 per cent. of the cases entered upon the sick reports were recorded as pneumonia, giving a ratio of one case of pneumonia to 19.32 cases.

Pneumonia and typhoid fever, together, caused 207 deaths out of 333, the entire number; that is, these two diseases alone occasioned nearly two-thirds of the entire number of deaths from all causes; or, more exactly, one death in every 1.6 deaths, or 62 per cent. of deaths. Whilst on the other hand, these diseases constituted only 7.65 per cent, of the entire number of cases.

Fewer cases of typhoid fever were received in 1863 than in 1862; thus in the former year, 74 were entered, whilst in the latter, the sum was about one-third greater, or 100.

In General Hospital No. 2, Savannah, Ga., during the nineteen months, (June, 1862 to December, 1863,) a small fraction over one-fourth of the cases of typhoid fever proved fatal; that is, one death occurred in every 3.918 cases, giving 25.5 as the percentage of deaths in the cases of typhoid fever. Of the total number of deaths, between one-third and one-fourth were from typhoid fever, or, more exactly, one death from typhoid fever in 3.378 deaths from all causes; thus yielding a ratio of deaths from typhoid fever, to the deaths from all causes, of 29.6 per cent. On the other hand, the ratio of cases of typhoid fever to the entire number of cases treated of all diseases was only 4.26 per cent., or between one twenty-third and one twenty-fourth of the entire number of cases (one case of typhoid fever occurred in every 23.4 cases of all diseases;) and the ratio of deaths from all causes, to the entire number of cases, was 3.67 per cent.

A little less than one-fourth the cases of pneumonia (or one in 4.32 cases, 23.14 per cent.) terminated fatally. One-fifth of the deaths from all causes, were due to pneumonia, whilst the ratio of cases of pneumonia to the entire number from all diseases, was only 3.174 per cent.

Pneumonia and typhoid fever together, caused 62 deaths out of 125, or very nearly one-half the entire number of deaths from all causes; whilst the ratio of cases of pneumonia and typhoid fever to the entire number of cases of all diseases was only 4.49 per cent.

Twenty-nine deaths, or nearly one-fourth of the entire number of deaths, were attributed to remittent and congestive fever, in Hospital No. 2, Savannah, Ga. From June, 1862, to December, 1862 (six months,) 13 deaths from remittent fever were recorded, out of only 141 cases treated; that is, nearly one-tenth of the cases of remittent fever during this period proved fatal. In view of the present enlightened and successful mode of treatment in this disease, this is certainly a remarkable ratio of mortality.

The statistics might be greatly extended, but they are sufficient for comparative purposes. The following tables will furnish the necessary data for comparison with the records of other hospitals:

Tables showing the Numerical Relations of the Cases and Deaths by Typhoid and Common Continued Fever and Pneumonia, in the General Hospitals in Virginia, and in several Hospitals in Georgia, during a portion of the war of 1861-1865. *Consolidated and Calculated from the official records on file in the office of Surgeon-General S. P. Moore, by Joseph Jones, M. D., Surgeon, P. A. C. S.*

CASES AND DEATHS FROM ALL DISEASES AND CAUSES.

NAME OF HOSPITAL.	DATES AND LENGTH OF TIME OF STATISTICS.	Total Sick and Wounded treated during this period.	Total Deaths from all Causes.........	Per cent. of Deaths in Cases..........	One Death in — Cases of all Diseases and Wounds.........
General Hospitals in Virginia, out of Richmond	Jan. 1862—Feb. 1863, (15 months)...........	113,914	5,516	4.84	20.65
General Hospitals in Virginia, in Richmond.....	Sept. 1862—Apr. 1863, (7 months)............	93,852	3,849	4.11	24.37
General Hospitals in Virginia........................	Apr. 1863—Aug. 1863, (4 months)............	108,165	2,705	2.5	39.98
General Hospital of Charlottesville, Va.....	July 1861—Sept. 1863, (26 months)...........	14,966	868	5.7	17.19
General Hospital No. 1, Savannah, Ga............	Dec. 1861—Jan. 1864, (25 months)...........	7,149	333	4.65	21.46
General Hospital No. 2, Savannah, Ga............	June, 1862—Jan. 1864, (18 months)...........	3,402	125	3.67	27.21
Guyton Hospital, near Savannah, Ga............	May, 1862—Jan. 1864, (20 months)...........	2,695	46	1.70	58.58

CASES AND DEATHS FROM TYPHOID FEVER AND COMMON CONTINUED FEVER.

NAME OF HOSPITAL.	DATES AND LENGTH OF TIME OF STATISTICS.	Total Cases of Typhoid and Common Continued Fever........	Total Deaths from Typhoid and Common Continued Fever...........	Per cent. of Deaths in Cases of Typhoid and Com. Continued Fever.	One Death in — Cases of Typhoid and Comm'n Continued Fever.......	Per cent of Cases of Typhoid and C. C. Fever in Total Cases........	One Case of Typhoid and C. C. Fever in — Cases of all Diseases and Wounds	Per cent of Deaths from Typhoid and C. C. Fever in — Deaths from all Causes......	One Death f'm Typhoid and C. C. Fever in — Deaths from all Causes.
General Hospitals in Virginia, out of Richmond...	January, 1862—February, 1863, (15 months).....	6,245	1,619	25.92	3.85	5.48	18.25	29.35	3.4
General Hospitals in Virginia, in Richmond........	Septe'ber, 1862—April, 1863, (7 months)	...	...	26.31	3.8	3.50	27.27	24.94	8.
General Hospitals in Virginia......	April, 1863—August, 1863, (4 months)	2,863	509	17.77	5.62	2.64	37.9	18.82	5.31
General Hospital of Charlottesville, Va	July, 1861—September, 1863, (26 months......	1,312	313	23.8	4.19	8.77	11.4	36.05	2.77
General Hospital No. 1, Savannah, Ga...........	December, 1861—January, 1864, (25 months).....	204	93	45.58	2.19	2,85	35.0	27.62	3.57
General Hospital No. 2, Savannah, Ga...........	June, 1862—January, 1864, (18 months)..........	239	42	17.57	5.66	7.02	14.23	33.6	2.97
Guyton Hospital near Savannah, Ga	May, 1862—January, 1864, (20 months)..........	105	11	10.47	9.54	3.89	25.66	23.69	4.18

CASES AND DEATHS FROM PNEUMONIA.

NAME OF HOSPITAL.	DATES AND LENGTH OF TIME OF STATISTICS.	Total Cases of Pneumonia......	Total Deaths f'm Pneumonia......	Per cent. of Deaths in Cases of Pneumonia.	One Death f'm Pneumonia in —— Cases of Pneumonia	Per cent. of Cases of Pneumonia in entire number of Cases.....	One Case of Pneumonia in —— Cases of all Diseases......	Per ct. of Deaths from Pneumonia in Deaths from all Causes......	One Death from Pneumonia in —— Deaths from all Causes......
General Hospitals in Virginia, out of Richmond...	January, 1862-- Feb'ry, 1863, (15 months)	4,774	1,261	26.41	3.78	4.16	23.86	22.86	4.37
General Hospitals in Virginia, in Richmond........	Sept'ber, 1862— April, 1863, (7 months)...	...	...	26.56	3.76	3.54	28.29	19.22	5.42
General Hospitals in Virginia......	April, 1863— August, 1863 (4 months)...	2,344	578	24.14	4.05	2.16	45.9	21.29	4.71
General Hospital of Charlottesville, Va	July, 1861–September, 1863, (26 months) ..	647	207	31.9	3.12	4.32	23.13	23.84	4.17
General Hospital No. 1, Savannah, Ga...........	December, '61-- January 1864 (25 months) ..	370	116	31.35	3.18	5.17	19.32	34.83	2.87
General Hospital No. 2, Savannah, Ga...........	June, 1862–January, 1864, (18 months) ..	108	25	23.04	4.32	3.174	31.5	20.00	5.00
Guyton Hospital near Savannah, Ga	May, 1862–January, 1864, (20 months)..	78	7	8.98	11.14	2.88	34.68	15.21	6.57

In the large number of cases (344,063) treated in these hospitals, 13,542 deaths are recorded and of this number typhoid fever and pneumonia caused very nearly one-half.

The last observation which we shall sustain by statistics, is that typhoid fever progressively diminished during the progress of the war, and disappeared almost entirely from the veteran armies; whilst, on the other hand, pneumonia continued to prevail, and appeared to be chiefly dependent upon the vicissitudes of the climate.

This statement is clearly sustained by the preceding statistics of the General Hospitals in Virginia.

The statistics which we consolidated from all the returns on file in the Surgeon-General's Office, do not extend over nineteen months, but even during this comparatively short period we observe a verification of the preceding observation, as will be shown by the following table:

Tables showing the Numerical Relations of the Cases and Deaths by Typhoid and Common Continued Fever and Pneumonia, in the General Hospitals in Virginia, and in several Hospitals in Georgia, during a portion of the war of 1861-1865. *Consolidated and Calculated from the official records on file in the office of Surgeon-General S. P. Moore, by Joseph Jones, M. D., Surgeon, P. A. C. S.*

CASES AND DEATHS FROM ALL DISEASES AND CAUSES.

NAME OF HOSPITAL.	DATES AND LENGTH OF TIME OF STATISTICS.	Total Sick and Wounded treated during this period.	Total Deaths from all Causes..........	Per cent. of Deaths in Cases...............	[illegible] and Wounds............
General Hospitals in Virginia, out of Richmond	Jan. 1862—Feb. 1863, (15 months)...........	113,914	5,516	4.84	20.65
General Hospitals in Virginia, in Richmond.....	Sept. 1862—Apr. 1863, (7 months)............	93,852	3,849	4.11	24.37
General Hospitals in Virginia......................	Apr. 1863—Aug. 1863, (4 months).............	108,165	2,705	2.5	39.98
General Hospital of Charlottesville, Va.....	July 1861—Sept. 1863, (26 months)...........	14,966	868	5.7	17.10
General Hospital No. 1, Savannah, Ga...........	Dec. 1861—Jan. 1864, (25 months)...........	7,149	333	4.65	21.46
General Hospital No. 2, Savannah, Ga............	June, 1862—Jan. 1864, (18 months)...........	3,402	125	3.67	27.21
Guyton Hospital, near Savannah, Ga...........	May, 1862—Jan. 1864, (20 months)...........	2,695	46	1.70	58.58

CASES AND DEATHS FROM TYPHOID FEVER AND COMMON CONTINUED FEVER.

NAME OF HOSPITAL.	DATES AND LENGTH OF TIME OF STATISTICS.	Total Cases of Typhoid and Common Continued Fever..............	Total Deaths from Typhoid and Common Continued Fever............	Per cent. of Deaths in Cases of Typhoid and Com. Continued Fever.	One Death in — Cases of Typhoid and Comm'n Continued Fever........	Per cent of Cases of Typhoid and C. C. Fever in Total Cases............	One Case of Typhoid and C. C. Fever in — Cases of all Diseases and Wounds............	Per cent. of Deaths from Typhoid and C. C. Fever in Total Deaths from all Causes..............	[illegible]
General Hospitals in Virginia, out of Richmond...	January, 1862—February, 1863, (15 months).....	6,245	1,619	25.92	3.85	5.48	18.25	29.35	[illegible]
General Hospitals in Virginia, in Richmond.......	Septe'ber, 1862—April, 1863, (7 months)..........	...	...	26.31	3.8	3.50	27.27	24.94	[illegible]
General Hospitals in Virginia......	April, 1863—August, 1863, (4 months).........	2,863	509	17.77	5.62	2.64	37.9	18.82	[illegible]
General Hospital of Charlottesville, Va.........	July, 1861—September, 1863, (26 months......	1,312	313	23.8	4.19	8.77	11.4	36.05	[illegible]
General Hospital No. 1, Savannah, Ga...........	December, 1861—January, 1864, (25 months).....	204	93	45.58	2.19	2.85	35.0	27.62	[illegible]
General Hospital No. 2, Savannah, Ga...........	June, 1862—January, 1864, (18 months)..........	239	42	17.57	5.66	7.02	14.23	33.6	[illegible]
Guyton Hospital near Savannah, Ga..................	May, 1862—January, 1864, (20 months)..........	105	11	10.47	9.54	3.89	25.66	23.69	[illegible]

CASES AND DEATHS FROM PNEUMONIA.

ME OF PITAL.	DATES AND LENGTH OF TIME OF STATISTICS.	Total Cases of Pneumonia..........	Total Deaths f'm Pneumonia..........	Per cent. of Deaths in Cases of Pneumonia.	One Death f'm Pneumonia in —— Cases of Pneumonia	Per cent. of Cases of Pneumonia in entire number of Cases.....	One Case of Pneumonia in —— Cases of all Diseases..........	Per ct. of Deaths from Pneumonia in Deaths from all Causes........	One Death from Pneumonia in —— Deaths from all Causes.......
Hospitals rginia, out chmond...	January, 1862—Feb'ry, 1863, (15 months)	4,774	1,261	26.41	3.78	4.16	23.86	22.86	4.37
Hospitals irginia, in nond........	Sept'ber, 1862—April, 1863, (7 months)...	...	...	26.56	3.76	3.54	28.29	19.22	5.42
Hospitals rginia......	April, 1863—August, 1863 (4 months)...	2,344	578	24.14	4.05	2.16	45.9	21.29	4.71
Hospital harlottes-Va	July, 1861–September, 1863, (26 months)..	647	207	31.9	3.12	4.32	23.13	23.84	4.17
Hospital Savan-a..........	December, '61—January 1864 (25 months)..	370	116	31.35	3.18	5.17	19.32	34.83	2.87
Hospital Savan-a	June, 1862–January, 1864, (18 months) ..	108	25	23.04	4.32	3.174	31.5	20.00	5.00
Hospital avannah, ...	May, 1862–January, 1864, (20 months)..	78	7	8.98	11.14	2.88	34.68	15.21	6.57

large number of cases (344,063) treated in these hospitals, 13,542 deaths are
and of this number typhoid fever and pneumonia caused very nearly one-half.
ast observation which we shall sustain by statistics, is that typhoid fever pro-
ly diminished during the progress of the war, and disappeared almost entirely
e veteran armies; whilst, on the other hand, pneumonia continued to prevail,
eared to be chiefly dependent upon the vicissitudes of the climate.

statement is clearly sustained by the preceding statistics of the General Hospi-
Virginia.

statistics which we consolidated from all the returns on file in the Surgeon-
l's Office, do not extend over nineteen months, but even during this comparatively
eriod we observe a verification of the preceding observation, as will be shown by
owing table;

In the preceding tables we observe a progressive and marked diminution of the of typhoid fever, whilst the yearly fluctuations of pneumonia are not referable to such law.

Thus, in the General Hospital of Charlottesville, during the year 1861, the disease and wounds numbered 4781, with 342 deaths; of this number, constituted 143 cases and 42 deaths, and typhoid fever 866 cases and 193 deaths. the year 1862, the total cases entered upon the hospital records, numbered 6692, 381 deaths; of these, there were of pneumonia, 370 cases and 138 deaths; fever, 299 cases and 91 deaths. During 1863, total cases, 4932, and deaths, pneumonia, 190 cases, 46 deaths; typhoid fever, 190 cases, 43 deaths. During total cases, 4850, deaths 208; pneumonia, 143 cases, 28 deaths; typhoid fever, cases and 30 deaths.

In the General Hospital of Charlottesville, during the first twenty-six months, largest number of cases of typhoid fever occurred in July, August, September October, 1861; and during the first thirteen months, (July, 1861 to July, 1862, months inclusive,) 1094 cases of typhoid fever entered the hospital; whilst during last thirteen months, (August, 1862 to August, 1863 inclusive,) only about the number of cases of typhoid fever entered, or, more exactly, 203 cases. During first period of thirteen months, 253 deaths from typhoid fever occurred; whilst the last thirteen months there were only 60 deaths, or not quite one-fifth the of the first thirteen months.

In the General Hospital of Staunton the cases of typhoid fever decreased in the lowing manner: in 1861, 868 cases and 47 deaths; in 1862, 779 cases and 239 in 1863, 365 cases and 58 deaths; in 1864, 192 cases and 29 deaths. The sum of cases of typhoid fever during both the years 1863 and 1864, was far less than either 1861 and 1862, notwithstanding that the total cases of diseases registered greater in 1863 and 1864.

CHAPTER XVII.

EXAMINATION OF THE DIFFERENT MODES OF TREATING PNEUMONIA.

and Importance of the Investigation, Dietetic System, which consists in allowing the
se to run its course, uninfluenced by drugs. Illustrative cases. Observations by Drs.
and Balfour.
l Treatment designed to further the natural progress of Pneumonia towards recovery.
d of Treatment advocated by Dr. John Hughes Bennett. Views of Dr. Robert Bently

gistic System of Treatment. The lancet abandoned by Southern physicians in the
ent of Pneumonia. The statistics to prove the wisdom of this step, wanting. Ex-
ion of the data by which the relative merits of the Antiphlogistic System of the treat-
f Pneumonia may be determined with some approach to accuracy. Investigations
is on Blood letting. Method and results of the Treatment of Pneumonia by Louis,
mes Jackson, Hughes Bennett, Rasori, Laennec and others.
of Pneumonia to Malaria. Relations of Pneumonia to Climate. Statistics of the
ent of Pneumonia by different methods.

EXAMINATION OF THE DIFFERENT MODES OF TREATING PNEUMONIA.

r a careful examination of the official reports, on file in the Surgeon General's
t Richmond, Virginia, I established the important fact, that up to the time of
mination, and consolidation of the sick reports and mortuary records (September,
Pneumonia and Typhoid fever, had caused one half the deaths from all causes,
ot wounds included, in the field and general hospitals. I was led to draw up
ed reports, presenting the results of my investigations on the causes and treat-
f the most fatal diseases. The manuscript volumes thus prepared, were captured
ned at the time of the evacuation of Richmond.

he official report on Pneumonia, I urged, that each Medical Officer of the Con-
te Army, should, as far as possible, test the value of the different modes of treat-
efore the profession. If such a plan could have been carried out by the Medical
s, in this gigantic struggle, it was believed that valuable contributions would
een made to the science of medicine. The plan of investigating the phenomena
hoid fever (*Camp fever*), addressed to the Surgeon General and the Medical
s of the Confederate Army, was also applied to Pneumonia.

mained that an effort should be made to point out the line of inquiry to be pur-
the investigation of the relative value of the different modes of treating Pneu-
that results capable of comparison might be obtained. It was urged that there
no want of theories, or of positive assertions, or of unbounded confidence, in
remedies in the treatment of Pneumonia: but unfortunately however, the so
experience, avails but little in the accurate determination of questions involving
s of a large proportion of those afflicted. It is customary to dignify with the
extensive experience, the use of one or more remedies, for a series of years,
t a number of patients, regardless of the intelligence which selected those reme-
d regardless of the fact whether those remedies were selected as the result of
on, or of accident or prejudice, or as the result of careful and conscientious inves-
and comparison of the relative effects and value of the different modes of treat-
It was urged, that under all circumstances, of peace or of war, and especia
st in which the entire community was emptied of its male population, fro

hood to old age, and from the statesman to the day-laborer, such investigations should be considered as of the greatest moment, and should be conducted with the most scrupulous accuracy and honesty; and the belief was expressed that with concert of action, amongst conscientious and competent observers, results of great value would be achieved.

In the report referred to, the various modes of treating Pneumonia, were classed under the following heads:

1st. Dietetic System; 2nd. Rational Treatment designed to further the natural progress of Pneumonia towards recovery; 3rd. Antiphlogistic System of Treatment; 4th. Antiperiodic, or Abortive Treatment of Pneumonia.

I. DIETETIC SYSTEM OF TREATING PNEUMONIA.

It is now established that Pneumonic inflammation is dependent upon definite conditions, and will without any assistance from the physician, run a definite course through successive stages, to recovery or death. The rate of mortality in cases left entirely to the operations of nature, will depend mainly on the amount of the lungs involved, whether one or both, and whether the whole lung, or only a small portion, and upon the pre-existing state of the system.

In the following case of Pneumonia, which I treated during the recent war, the remedies employed were of the mildest character.

Case 702. *Circumscribed Pneumonia, attended with high fever, arrested or resolved in second stage.*

Andrew Jackson Sharpe, Confederate soldier; Private; age, 25; height, 5 feet, seven inches; weight, 150 lbs.; black hair, dark eyes.

Had measles in the month of June 1862, in this hospital, and regained his usual health.

General Confederate Hospital, Augusta, Georgia, July 17th, 1862. Patient siezed with rigor, followed by pain in right side, high fever and troublesome cough.

July 18th. Pain in side severe, cough painful and troublesome; skin hot and dry; pulse and respiration accelerated; dullness upon percussion over right lung. I ordered nothing but the internal use of cold water, in such quantities as the thirst of the patient might dictate. Evening, skin hot and dry; pulse 112; cough painful and troublesome; patient very restless.

July 19th, 12 M. Pulse 100; respiration 24; temperature of hand 41°C (105°. 8 F); of axilla 41°. 85 C. (107°. 4 F). Right lung dull on percussion; auscultation revealed minute crackling crepitation, with some increase of vocal fremitus. The natural resonance of the lung was more diminished, and the sense of resistance increased, more especially over the lower lobe of the right lung. At first the expectoration consisted only of glairy mucus, but it now presents the rusty color, and viscid tenacious characters of the characteristic pneumonic sputa. Patient restless and depressed, and the hot "*burning*" fever causes him to toss incessantly from side to side in the bed. Breathing oppressed, and painful and hurried. Tongue dry and red. Severe pain in head.

℞. Tinct. Opii, two fluiddrachms; Pulv. Ipecac, ten grains; Sodæ, Proto Carb., two drachms; Flaxseed tea, ten fluidounces. Wineglassful every two hours, or at shorter intervals, if the cough is troublesome. Apply flannel, saturated with oil of turpentine, over the region of the lower and middle lobes of the right lung. Cold water as a drink, ad libitum.

Examination of Urine:—Amount of Urine passed during the preceding twenty-four hours, July 18th, 12 M. to July 19th, 12 M., Grains 15,996.56. Specific Gravity 1016.3. Golden-yellow color. Reaction acid.

No. 87. Analysis of Urine Passed during twenty-four hours:

	Urine Passed During Twenty-four Hours. Grains:	Urine Passed Each Hour. Grains:
Amount of Urine	15,996.56	666.52
Urea	432.32	18.00
Uric Acid	5.00	0.20
Free Acid	69.48	2.89
Phosphoric Acid	60.56	2.52
Sulphuric Acid	37.73	1.57
Chlorine	13.11	0.54
Equivalent Chloride of Sodium	21.58	0.89
Phosphates of Lime and Magnesia	17.00	0.70

Evening. The mixture caused the patient to vomit freely, and "much bile was thrown off." The Ipecac and Soda mixture also excited free perspiration. The patient is now (9 P. M.) in a gentle sleep, and the skin is bathed in perspiration. ℞. Continue Ipecac and Soda mixture.

July 20th, 12 M. Pulse 70. After the relief of the stomach by the emetic, the severe headache disappeared, and has not returned, and the patient appears to be better. Skin moist, and the temperature is not so elevated. Respiration more regular and less painful. Expectoration still rusty-colored, tenacious and gelatinous.

Continue turpentine stupes to the chest, and also the Ipecac and Soda mixture.

July 21st, 2 P. M. Patient continues to improve; temperature of hand, 36°. 1 (97.° F); of axilla 38°. C. (100°. 4 F); pulse 52; respiration 20; skin feels cool and moist—in a profuse perspiration: pulmonary symptoms improved; the rusty colored sputa has disappeared and been superceded by clear, viscid sputa. The right lung is less dull on percussion, although the crepitant rales continue.

Examination of Urine: Amount of Urine passed during forty-eight hours, July 19th, 12 M., to July 21st, 12 M. Grains, 28,980.48; Specific Gravity, 1022.6; orange colored. Upon standing, the urine emits a putrid smell, and throws down a heavy deposit of urates and phosphates.

No. 88.—Analysis of Urine passed during forty-eight hours:

	Urine, Forty-eight Hours. Grains:	Urine, Twenty-four Hours. Grains:	Urine Each Hour. Grains;
Amount of Urine	28,980.48	14,490.24	603.76
Urea	1,181.16	590.58	24.61
Uric Acid	34.00	17.00	0.70
Free Acid	166.75	83.37	3.47
Phosphoric Aeid	109.01	54.50	2.26
Sulphuric Acid	58.32	29.16	1.21
Chlorine	6.22	3.11	0.12
Equivalent Chloride of Sodium	10.26	5.13	0.21
Phosphates	14.45	7.22	0.30
Phosphates and Sulphates and Carbonates of Soda, Potassa	134.27	67.13	2.79

July 22d, 9 P. M. The left lung appears to be involved to a certain extent. The cough is more troublesome than yesterday, and the rusty colored pneumonic sputa has returned. In addition to the crepitant and sub-crepitant rales, mucous rales are heard distinctly in lower and middle tubes of right lung. The pulse is regular and compressible, and the skin is moist. Tongue clean.

Notwithstanding some apparent increase in the pneumonic symptoms, the patient says that he feels much better. The patient was placed upon a mixture composed of Camphorated Tincture of Opium, one fluidounce; Syrup of Ipecac, three fluidounces; Honey, four fluidounces. Teaspoonful every two hours.

July 23d. Continues to improve.

July 24th, 12 M. Pulse 76; respiration 16; Temperature of hand 38°. 4 C (101°. 1 F); of axilla 38°. 5 C (101°. 3 F); tongue clear; patient much better.

Examination of Urine:—Amount of Urine passed during the last seventy-two hours. Grains 45,004.07; Specific Gravity, 1023. Upon standing, the urine changed rapidly to the alkaline condition and emitted a putrid odor.

No. 89. Analysis of Urine passed during seventy-two hours—July 21st, 12 M., to July 24th, 12 M.

	Urine, Seventy-two Hours. Grains:	Urine, Twenty-four Hours. Grains;	Urine, Each Hour. Grains:
Amount	45,004.07	15,001.35	625.05
Urea	2,134.52	711.50	29.64
Phosphoric Acid	105.02	35.00	1.45
Sulphuric Acid	180.86	60.28	2.51
Chlorine	54.90	18.30	0.76
Equivalent Chloride of Sodium	93.32	31.10	1.21

The patient continued to improve rapidly, and, in fact, on this day (July 24th), was dressed and walking about the ward, although the temperature was about three and a half degrees above the normal standard.

In the preceding Case, 702, although but little medicine was employed, and that of the mildest character, the pneumonic inflammation resolved spontaneously, and did not pass into the stage of hepatization and suppuration. There was no subsequent purulent expectoration, and the recovery of the patient was rapid and complete. The favorable result in this case could scarcely have been predicted or hoped for, on the 19th of July, third day of disease, when the temperature of the axilla was 107°.4 F., and of the palm of the hand, grasping the thermometer, 105°.8 F. The temperature of the internal organs was, without doubt, at least from two to three degrees higher, and probably reached 110° F.

That high degrees of febrile heat are not necessarily fatal in Pneumonia, will be clearly shown by an examination of the outlines of the histories of the two following cases, 703 and 704, which I treated successfully in the Charity Hospital of New Orleans:

CASE 703: *Double Pneumonia; Great Elevation of Temperature; Recovery.*

John Venwick, age 23; laborer; stout, muscular, well built man. Admitted into Charity Hospital, ward 13, bed 195, December 9th, 1873, in the evening. I saw this patient for the first time, December 10th, 8 A. M. Skin hot; cheeks flushed; pulse 104; respiration 20; tongue furred, and red at tip and edges; temperature in axilla 104° F.; no appetite; pain in left side; bowels constipated; restless; considerable thirst; dullness over lower lobe of left lung, which is most marked posteriorly.

Breathing weak in the lower lobe and lower portion of the middle lobe of right lung, but exaggerated in the superior portions. Vocal fremitus increased; bronchial breathing and bronchophony, with feeble crepitation heard over those portions of the right lung which were especially dull upon percussion. Expectoration scanty; the sputa consisting of thick, gelatinous, rusty colored, fibroid exudation. Urine devoid of chlorides; no albumen: urea and uric acid, Phosphoric and Sulphuric acids increased; coloring matter of bile and bile acids present. I ordered the following: ℞. Emplastri Cantharidis, 6 by 8 inches, over lower portions of right chest. ℞. Quiniæ Sulph., half drachm; Pulv. Doveri, half drachm; mix, divide into 10 powders; one powder every three hours. ℞. Liq: Ammoniæ Acetatis, (Spts. Mindereri), half a fluidounce every two or three hours. Diet, Milk Punch and Beef Tea.

Eight o'clock P. M.—Patient suffering much pain, with great oppression of respiration. Skin hot and dry. Temperature of axilla, 106°.2 F. Continue treatment. The blister has not had the usual effect.

December 11th, 8 A. M.—The patient was delirious during the night. This morning the skin is hot, but bathed in perspiration. Features haggard and pinched. Cheeks much flushed. Pulse 116, full and bounding. Respiration 54, panting, oppressed and painful. Temperature of axilla 104°.8 F. Pneumonic inflammation progressing in lower and middle lobes of right lung, and it has also invaded the lower lobe of the left lung, which is dull upon percussion, and emits crepitant rales. Expectoration has ceased.

℞. Tinct. Veratri Viridi, 5 drops every three hours. Continue Solution of Acetate of Ammonia, and Quinine and Dover's powders. Dress blister with Simple Cerate. Milk Punch and Beef Tea in small quantities, at regular intervals of two hours.

Eight o'clock P. M.—Respiration rapid and panting, about 60 per minute; pulse full and rapid. With the invasion of the left lung by the pneumonic inflammation, there has been a progressive rise of temperature, and the thermometer in the axilla indicates 109° F. It is probable that the temperature of the blood in the internal organs is between 111° and 113° F. No trace of chlorides in the urine, which is of a brownish red color, and entirely free from albumen. No expectoration from lungs.

December 12th, 8 A. M.—Pulse 108; respiration 26. The fever subsided gradually during the progress of the night, and the patient breathed easier and obtained some refreshing rest. The temperature has fallen 5°.5 F., and the thermometer now indicates in the axilla, 103°.5 F. Careful examination of both lungs, by auscultation and percussion, reveals the fact that there has been no fresh portion of lung invaded, and that crepitation is now heard in portions of the lungs which were devoid of all respiratory sounds, except bronchial breathing. The expectoration has reappeared, and the sputa presents the appearance of thick, semi-transparent jelly, which adheres firmly to the bottom of the vessels in which it is received. Chlorides still absent from urine. No altbumen in urine. I regarded the arrest of the pneumonic inflammation in both lungs, and the reappearance of the expectoration, and the marked diminution of the temperature, and the absence of delirium, as most favorable signs in this apparently hopeless case.

Eight o'clock P. M.—Patient continues in much the same state, although, as was to have been expected, under any circumstances, there has been a slight rise of temperature, the thermometer indicating 104° in the axilla. There has been no increase of the pneumonic inflammation during this day, and there is just grounds for a favorable prognosis. I attributed the arrest of the pneumonic inflammation to the combined effects of the Veratria, Quinine and Dover's Powders. The blister also, as well as the administration of nourishment and alcoholic stimulants at regular intervals, may also have contributed to the favorable result. With the arrest of the progress of the pneumonic inflammation, that is, as far as the invasion of fresh portions of the lungs is concerned, there has been a progressive decrease in the frequency of the pulse and respiration.

December 13th, 8 o'clock A. M.—Continues to improve; expectoration more abundant; air penetrating gradually the solidified portions of lungs, crepitant and sub-crepitant rales being heard in the solidified portions of both lungs. Chlorides have reappeared in small quantities in Urine. Pulse 100; respiration 24; Temperature of axilla 104°.4 F.

Eight o'clock P. M.—The patient has continued to improve, and the temperature to descend, and now stands at 102° F., having fallen during the past 12 hours, 2°.4 F., and the past three days, 7° F.

December 14th, 8 o'clock A. M.—Continues to improve. Pulse 84; respiration 28; temperature of axilla 101°.4 F. 8 o'clock P. M.—Temperature of axilla 99°.8 F.

On the following day, the temperature rose to 101°.5 F., and for several days oscillated between 99°.5 F. and 101° F. The recovery of this patient was complete, without any abscess of lung, or purulent expectoration, and he was discharged from my service in good health.

CASE 704: *Double Pneumonia; Temperature of Axilla reached* 109° *F.; Abscess of Lung; Tedious Convalescence; Recovery.*

August Raville; native of Italy, age 21. Black hair and eyes, florid complexion. Entered Charity Hospital, ward 25, bed 377, November 19th, 1873. Says that he was taken sick two days before entering the hospital, and that he had suffered with chills and fever occasionally during the autumnal months.

Complained of pain in right lung, difficulty in breathing, loss of appetite, thirst, and pain in the head, back and lower extremities. Five grains of Quinine and twenty drops of Tincture of Opium (Laudanum), were administered, and sinapisms applied to the chest. November 20th, the pain continues to increase upon the right side, the cheeks are flushed, and auscultation and percussion reveal the presence of pneumonic inflammation in the middle and lower lobes of the right lung. Pulse 100; respiration 52.

November 21st, 8 A. M.—Pulse 116; respiration 56; temperature of axilla 104° F. Great dyspnœa, rapid respiration. Cheeks of a purplish red color. Sputa consists of blood, mixed with tenacious, jelly-like matter. Cough troublesome and painful. Pain in the right side, greatest about three inches below the nipple, and extends towards the back. Patient was restless and delirious during the preceding night. Tongue rough and covered with a yellowish fur in the centre. Pulse rapid, full, strong and compressible. Upon percussion, right lung dull over region of middle and lower lobe.

Auscultation reveals crepitation, in inspiration, with bronchial respiration and increased vocal fremitus over the lower and middle lobes of right lung. R. Quiniæ Sulph., Pulv. Doveri (Ipecac et Opii), of each, one scruple; mix; divide into four powders. Sig: One powder every four hours. Apply Turpentine stupes over right side. Milk Punch and Beef Tea at regular intervals. 8 o'clock P. M: Temperature of axilla, 105° F.

November 22d, 8 A. M.—The patient passed a disturbed, restless night, but appeared to be more comfortable this morning, the pulse being 106 and the respiration 24. Auscultation and percussion revealed no increase in the pulmonary disease. The treatment and diet were continued. The temperature, also, of the axilla, has fallen one and a half degrees, and is 103°.5 F.

Shortly after this observation, the patient expressed a desire to receive "extreme unction" from the Catholic Priest. He was accordingly, (without my knowledge or consent), taken out of bed and placed in a chair, with his feet resting upon the bare floor. This exposure brought on severe pain in the left lung also, with a rapid rise of the temperature, and at 8 P. M., the thermometer in the axilla stood at 109° F. The temperature of the blood in the internal organs was most probably as high as 112° or 113° F.

November 23.—Patient delirious during the night, it being necessary to confine him to the bed. The burning fever appeared to abate towards morning.

Eight o'clock A. M.—Restless, anxious, and at times delirious. Cheeks flushed, and of a purplish blue color; lips and hands congested. Respiration rapid and panting. Expectoration almost entirely suppressed. Respiration rapid, embarrassed and painful. Lower lobe of left lung dull upon percussion, with crepitant rales and tubular breathing. Pneumonic symptoms of right lung aggravated.

Pulse 130; respiration 56; temperature of axilla 102°.5. The exposure of yesterday has evidently excited fresh inflammatory actions in the lungs, both of which are now involved and the remarkable rise of temperature to 109° F., during the evening, was evidently due to the sudden spread of the pneumonic inflammation.

I ordered the Quinine, and Dover's Powders, and Turpentine Stupes, and Beef Tea, and Milk Punch to be continued as before, and ordered, in addition, the following: R. Liq: Ammoniæ Acetatis, half a fluidounce every two hours. R. Tinct. Jelseminum Sempervirens (Yellow Jassamine), ten drops every four hours.

Under these measures, the fever slowly declined; a large portion of the right lung, however, passed into the stage of solidification and gray hepatization. A large cavity formed in the middle lobe of the right lung.

In this case, during the changes of the pulmonary textures resulting from the pneumonic inflammation, the temperature for one hundred days oscillated between 100° and 104° F., the mean ranging between 101° and 102° F., as in some cases of Phthisis Pulmonalis. Under the continuous employment of Quinine, Iron, bitter tonics, gentle expectorants and Cod Liver Oil and nutritious diet, I had the satisfaction of seeing this patient restored to health after an illness extending over four months. Daily observations were taken of the pulse, respiration and temperature, with observations upon the physical changes of the lungs and the characters of the urine, but it would extend this report to too great a length to present the details.

The Confederate soldier, Andrew Jackson Sharpe, whose case has been detailed, No. 702, had in the month of August following, an attack of Intermittent Fever, and I was thus enabled to institute a comparison between the phenomena of this disease and those of pneumonia, occurring in the same individual.

CASE 705: *Intermittent Fever following Pneumonia in the Same Individual.*

Andrew Jackson Sharpe, Confederate soldier; had an attack of Pneumonia, which we have recorded (Case 702).

August 21st.—Had a chill this morning, about 8 o'clock, and at the present time, 11 o'clock A. M., has fever. Pulse 94, respiration 28, temperature of hand 41°.4 C., 106°.6 F., temperature of axilla, 41°.6 C., 106°.9 F. Face flushed. Urine light colored. Urine passed after the chill, during the onset and height of the fever, normal in color, limpid, without deposit, even after standing several days; reaction strongly acid; specific gravity 1011. Amount of urine passed during 10 hours of the commencement and height of the fever, 7794 grains.

No. 90. Analysis of Urine passed during Ten Hours of the commencement and height of a paroxysm of Paludal Fever.

		Urine passed during 10 hours. Grains.
Amount of Urine		7794.81
Phosphoric Acid		2.96
Sulphuric Acid		10.08
Chlorine		42.75
Fixed Saline Constituents, 74.22,	Equivalent Chloride of Sodium	70.56
	Phosphates of Lime and Magnesia	0.23
	Phosphates, Sulphates and Carbonates of Soda, and Potassa.	3.34

The saline constituents consisted almost entirely of Chloride of Sodium, whilst the Potassa salts appeared to be, in a great measure, absent. The presence of Chloride of Sodium, and the absence of the Phosphates and Potassa salts in the urine during the active stages of malarial fever, correspond with the pathological changes which we have demonstrated by the analysis of the blood and urine, and organs, in a large number of cases. During the chill of Paludal fever, the spleen and liver, and, in fact, all the central organs, but more especially the spleen and liver, are congested with blood. The changes of the blood in the liver and spleen, are of a peculiar nature: there is not a *mere* congestion and stagnation of the blood; important changes take place in the blood of these engorged organs. I have determined by numerous microscopical observations, as well as by chemical analysis, that the *mud* of the enlarged and softened malarial spleen consists almost entirely of dead and altered colored blood corpuscles. So also the liver contains vast numbers of pigmentary fragments deposited chiefly in the periphery of the lobuli, and which have resulted from the destruction and alteration of the colored blood corpuscles. The denial of the existence and the pathological significance of the pigment particles of the liver and spleen in malarial fever, can be referred only to absolute ignorance of the natural history and pathology of this disease, and to gross incompetency in the use of the microscope.

It is impossible that the pigment particles of the liver and the spleen of malarial fever, which consist chiefly of altered hæmatin, should escape the attention of any competent microscopist.

After the active congestion of the liver and spleen during the cold stage, the blood corpuscles which have been withdrawn from the circulatory fluid, undergo profound alterations. Therefore, after the chill, an impoverished blood circulates and undergoes chemical change. This blood is characterized by a deficiency of colored corpuscles, and a preponderance of the liquor sanguinis; and, hence, it appears that the urine excreted during the first stages of the paludal paroxysm presents corresponding characters:—as Chloride of Sodium is the salt which more especially characterizes the liquor sanguinis, it will appear in the greatest abundance in the urine; and as the colored blood corpuscles have been withdrawn in a great measure from the general circulation, we have during such withdrawal a clear, limpid, colorless urine. As a large portion of the colored blood corpuscles have been temporarily withdrawn from the general mass of the circulation, the salts peculiar to them, and resulting from the chemical changes of their component elements, viz: the phosphates of potassa, lime, magnesia and iron, will in a great measure disappear from the urine.

August 22d, 11 A. M.—Pulse 66; respiration 22; temperature of hand 38°. C. (100°. 4 F.); of axilla 38°. 3 C. (101° F.) Patient in a good perspiration; fever appears to be declining, which change commenced about 7 A. M., when sweating commenced.

Examination of Urine:—The urine passed during the gradual subsidence of the fever, was much more deeply colored than the urine of fever, and presented a reddish color. Amount of urine passed during fourteen hours after the decline of the fever, from August 21st, 10 P. M. to August 22d, 12 M.: Grains 9601.20; specific gravity 1016. The phosphoric acid appeared to be combined chiefly with the alkalies, for ammonia failed to precipitate but a very small quantity of phosphates of lime and magnesia, and, in fact, so small a quantity, that it was found impracticable to filter them from the urine. The crystals also appeared to be unusually small, and to pass readily through the filter. The saline constituents consisted in considerable measure of common salt, but not to so large an extent as during the fever.

No. 91:—Analysis of Urine passed during fourteen hours—August 21, 10 *P. M. to August* 22, 12 *M:*

		Urine Passed During Fourteen Hours. Grains:
Amount of Urine		9601.20
Phosphoric Acid		29.07
Sulphuric Acid		19.20
Chlorine		36.30
Fixed Saline Constituents 76.50	Equivalent Chloride " of Sodium	59.84
	Phosphates and Sulphates of Lime, Soda and Potassa	16.66

We observe a decided increase of phosphoric acid and phosphates. Some of the characteristic changes of the urine in malarial fever are shown in the two preceding analyses.

These changes correspond with the phenomena. As *paroxysms* characterize the phenomena of malarial fever, so do marked changes, at different periods of the disease, characterize the urine

August 23d, 12 M.—Pulse 80; respiration 24; temperature of axilla 38°. 5 C. (101°. 3 F.)

Examination of Urine:—Heavy crystalline deposit in urine, of phosphates of lime, magnesia and ammonia, and of urates and uric acid. Amount of urine passed during the last twenty-four hours: Grains 12,927.60; specific gravity 1026.

No. 92:—Analysis of Urine passed during twenty-four hours, August 22d, 12 *M., to August 23d,*12 *M.*

		Urine Passed During Twenty-four Hours. Grains:
Amount of Urine		12,927.60
Phosphoric Acid		52.93
Sulphuric Acid		43.54
Chlorine		64.90
Entire Saline Constituents 146.43	Equivalent Chloride of Sodium	106.99
	Phosphates of Lime and Magnesia	15.81
	Phosphates and Sulphates ot Potassa and Soda	23.63

By a comparison of the various analyses of the urine in this case, we observe a progressive increase in the saline constituents, and especially of the phosphates of lime and magnesia.

Absolutely no medication was employed in the preceding case, so that it furnishes data for the comparison of the phenomena of Pneumonia and Paroxysmal fever, occurring at different times in the same individual.

That cases of fever should arise in a hospital, or in camp at any time, independently of the effects of exposure or fatigue, or the supervention of any recognizable inflammatory lesion, may be accounted for in a measure by the fact, that tents and hospitals are often loaded with deleterious exhalations, which may be capable of inducing febrile excitement in the animal economy. Sudden check of perspiration, may also induce general febrile excitement, not so much as Dr. Hall and others would have us believe, from an impression upon the sensitive nerves of the surface transmitted through the central spinal ganglia, and reflected upon the sympathetic and vaso-motor nerves, as from the sudden suppression and perversion of the functions of the extensive glandular system of the skin, and the consequent retention of deleterious matters in the blood, which are capable of affecting the nervous system and inducing febrile action. In the problem of the action of the emunctories of the skin, and of the amount and chemical composition of the matters eliminated, cold or temperature enters as a material element. It is possible that the phenomena may be explained without resort to the theory of the transmission of nervous influence to internal organs. Disturbances in the electric phenomena of the nerves and muscles, and of the secretions, should also be considered in the discussion of the origin of Irritative fever and inflammations. I select the following case of Irritative fever, arising spontaneously in my hospital practice during the civil war, as affording materials for comparison with the case of Pneumonia (702) previously recorded, in that it was treated strictly upon the so called *expectant* plan, without drugs.

CASE 706: *Fever originating in Military Hospital, without any assignable cause, and without any discernible local inflammation; treated upon the Expectant plan, without drugs.*

Powers, Confederate soldier; age 18; height 5 feet 7 inches; weight 115 pounds; light hair, fair complexion. Has been in the General Hospital, C. S. A., Augusta, Georgia, for 4 weeks. Entered with bronchitis, and in an anæmic condition. Native of Marion District, South Carolina. Says that he had chills and fever last year; and has had pneumonia three times in his life. During his stay in this hospital, has been treated with Quinine, Iron, and bitter tonics, and supplied with nutritious diet. Under this treatment the patient has improved rapidly, gaining both in flesh and strength, and presenting a clear, healthy complexion. The patient was in apparent good health, and fit for active service in the field, when on the night of July 18th, 1862, he was seized with severe pain in his head, followed by high fever the pulse beating 120 per minute and the temperature of the axilla reaching 106° F.

July 19th, 12 M., pulse 120; skin hot and dry; tongue moist, but red. Ordered his urine saved from this moment. I prescribed nothing, but directed that the patient should be supplied with cold water, ad libitum.

July 20th, 11 A. M. Much better; skin cooler; pulse 112; skin warm but moist; tongue red but moist. Bowels have been moved four times and are inclined to diarrhœa. Urine orange colored. Nothing ordered beyond cold water and simple nutritious diet.

July 21st, 2 o'clock P. M. Pulse 92; respiration 22; temperature of hand 36° C., (98° F.;) of axilla 38°.4 C., (101°.1 F.)

Examination of Urine. Amount of urine passed during the last 48 hours; grains, 31,890. 8; specific gravity, 1012. 4. Urine rapidly underwent putrefaction, and emitted an offensive smell, as in that of the case of Pneumonia, 702; while on the other hand the urine excreted during the active stages of malarial fever, as in case 705, did not undergo a similar change and emit an offensive odor, until the febrile excitement had subsided.

No. 93. Analysis of Urine passed during forty-eight hours.

	Forty-Eight hours.	Twenty-four hours.	Each hour.
	Grains.	Grains.	Grains.
Amount of Urine	31,890.60	15,945.30	664.38
Urea	741.12	370.56	15.44
Uric Acid	22.68	11.34	0.47
Free Acid	46.32	23.16	0.96
Phosphoric Acid	96.90	48.45	2.01
Sulphuric Acid	47.53	23.76	0.99
Chlorine	15.82	7.91	0.32
Equivalent Chloride of Sodium	26.05	13.02	3.13
Phosphates and Sulphates of Lime, Magnesia, and of Potassa and Soda	150.35	75.17	0.54

July 22d P. M. Free of fever, pulse 84; skin cool.

July 23d, 2½ P. M. Pulse 96; respiration 22; temperature of hand 36°.8 C., (98°.2 F.;) of axilla, 38° C., (100°.4 F.;) skin moist; tongue red.

Examination of Urine.—Amount of urine passed during the last forty-eight hours; grains 19,857.12; specific gravity, 1009; normal color, slight deposit.

No. 94. Analysis of Urine passed during forty-eight hours.

	Forty-Eight hours.	Twenty-four hours.	Each hour.
	Grains.	Grains.	Grains.
Amount of Urine	19,857.12	9,928.56	413.69
Urea	636.90	318.45	13.26
Phosphoric Acid	22.71	11.35	0.47
Sulphuric Acid	44.10	22.50	0.93
Chlorine	3.57	1.78	0.07
Equivalent Chloride of Sodium	5.48	2.94	0.12

P. M. Free of fever; pulse 80; surface of body feels cool and natural.

July 24th, 1 P. M. Pulse 96; respiration 16; temperature of hand, 36°.4 (97°.5 F.;) of axilla 38°.2 C., (100°.7 F.)

Examination of Urine.—Amount of urine passed during twenty-four hours; grains 9,515.52; specific gravity, 1008; straw colored; heavy deposit of phosphates and urates. Alkaline reaction and putrid odor.

No. 95. Analysis of Urine passed during twenty-four hours.

	Urine Twenty-four hours.	Urine each hour.
	Grains.	Grains.
Amount of Urine	9,515.52	396.48
Urea	236.23	9.84
Phosphoric Acid	7.62	0.30
Sulphuric Acid	11.31	0.47
Chlorine	1.48	0.06
Equivalent Chloride of Sodium	2.43	0.10

During this day, all traces of the fever subsided, and the only perceptible effects, were those of debility—the complexion being rendered paler, the skin more relaxed, and the patient more languid and feeble than in health. As far as could be determined by physical exploration and chemical research, no organ was implicated in this fever. With the exception of several discharges from the bowels, on the 20th no derangement of any of the viscera were manifested, and this slight disturbance of the alimentary canal, might have been produced by the copious draughts of cold water.

The consideration of the spontaneous resolution of such cases of fever, which in their onset, forbode serious consequences, is important in the warning which it gives against the unconditional acceptance of the statements of those who assert, that certain fevers, and especially Typhoid fever, can be aborted or strangled in the earliest
certain remedies and measures. If in this case (706,) Quinine or Opium, or
remedy, had been used, the physician might have attributed the gradual sub

the fever, to the so-called *abortive effects* of his drugs; whilst in reality, nature needed no assistance;—either the poison producing the fever being so limited in amount, as to be readily destroyed during the changes of fever,—or else, the disturbances in the nervous system and blood, and organs, were so slight, as to be readily re-adjusted, by the working of the natural and fixed laws of the economy. It would also be a subject of inquiry to determine how far the free use of cold water internally, may have promoted the favorable result; as well as the probable effects of the withdrawal of this agent, and free supplies of fresh air upon the progress and results of such a case of fever.

An examination of the changes of the urine in the preceding case, reveals the fact that the chlorine was diminished to a marked degree. The diminution of this element is characteristic not alone of pneumonia, but all those diseases, as Typhoid fever, Small Pox, and Remittent fever, which continue for a considerable length of time, and in which little or no nutriment is taken. We have shown that the chlorides may be diminished to a marked extent even in Traumatic Tetanus. It would expand the present volume to too great an extent to detail the observations which we have made upon the urine in Pneumonia and various other diseases in order to illustrate the chemistry, pathology, and treatment; and I will content myself with an expression of such general conclusions as will illustrate certain questions relating more especially to the method of treatment.

1st. During the active stages of Pneumonia, the Urea, Uric Acid, Free Acid, Phosphoric Acid and Sulphuric Acid, are present in increased quantities in the urine; and such increase is evidently due to the metamorphosis of tissue during the increased chemical changes of the forces.

2d. During the active progress of the Pneumonic Inflammation, the chlorine rapidly diminishes in amount and may entirely disappear; and its re-appearance in the urine and progressive increase indicates an arrest of the farther progress of the pneumonic inflammation. The reappearance of the chlorides in the urine may indicate the commencement of convalescence, before auscultation and percussion afford any information as to the progress or arrest of the pneumonic inflammation in the sound portions of the lungs.

A similar observation is also true with reference to the indications afforded by the thermometer. The retention of the chlorides is connected with the morphological changes of the pneumonic exudation, and their excretion is increased, during the absorption and disappearance of the exudation.

3d. In malarial fever, on the other hand, during the chill and early stage of the febrile excitement, Chloride of Sodium appears in increased amounts, whilst there is a marked diminution of Uric Acid and Phosphoric Acid.

During the cold stage, the colored blood corpuscles are accumulated and altered in the liver and spleen; and during the hot stage an impoverished blood circulates and undergoes chemical change; as this blood is characterized by a preponderance of the liquor sanguinis; and as the chloride of sodium is the most abundant and characteristic salt of the Liquor Sanguinis, it will appear most abundantly in the urine. As a large portion of the colored blood corpuscles have been temporarily withdrawn from the general mass of the circulation, the salts peculiar to them and their chemical changes, viz: the Phosphates of Iron, Lime and Potassa, will in a great measure disappear from the urine. Owing to the congestion of the liver, the bile also is altered in its properties, and appears to be excreted in larger quantities than in health.

4th. During the continuance of the fever however, the urine becomes of a deeper color, the Phosphoric Acids and Potash Salts, and Uric Acid gradually increase. The increase of those constituents, in the urine during the progress of the fever, is readily explained, by the fact that the altered blood corpuscles during the active changes of the fever, are themselves drawn into the round of chemical change, undergo decomposition, and yield up the coloring matters and salts to the eliminating action of the kidneys.

5th. The remarkable changes of temperature, as well as the internal congestions characteristic of the chill, are probably due to the action of the malarial poison, or of the blood altered by the paludal poison, upon the internal ganglionic centres. This appears to be indicated by the remarkable fact, that during the chill, there is an actual elevation of the temperature of the trunk sometimes as high as 107° F., whilst there may be a reduction of the temperature of the extremities as low as 87° F., or ten degrees below the standard of health, and 20 degrees below the temperature of the trunk. This phenomena resembles in some respects that of the division of the sympathetic in the neck. There is then during the chill a paralysis of the sympathetic system, a dilatation of the largest blood-vessels, and especially of the veins and sinuses and capillaries of the brain, spinal cord, liver and Spleen, and an accumulation of blood in the central organs; and attending this stagnation of the blood in the central organs, and contraction of the capillaries of the periphery of the body, there is an actual rise in the temperature of the mass of blood, as if by some agent or ferment, rapid chemical change was excited in the vital fluid. It is a question whether the paralysis of the vessels of the surface, be due to direct action of the vaso-motor nerves, or to the accumulation of the blood in the large central organs, consequent upon the paralysis of the ganglia of the sympathetic Cerebro-Spinal system, which preside over circulation and animal heat. When the chills recur frequently, these phenomena will be frequently repeated, becoming less distinct as they approach each other; and in the remittent form of fever, they are less marked, and the changes of the urine present greater uniformity.

6th. The disappearance of the Phosphoric Acid from the urine in the early stages of the paroxysm, also indicate, perversion or arrest of the normal and nutritive and chemical actions of the nervous system.

7th. In Typhoid, (Enteric, Continued, Camp) fever, uniformity characterizes the phenomena; whilst paroxysmal changes characterize those of malarial fever. In Typhoid fever the colored blood corpuscles are not specially altered, either in character or amount; neither are the spleen and liver specially affected.

8th. Typhoid fever is characterized by an elevated temperature with slight morning and evening variations; great mental, nervous and muscular depression; rapid chemical change of the elements of the nerves, muscles and blood; great and continuous increase in the amounts of Urea, Phosphoric and Sulphuric Acid excreted in the urine.

9th. Pneumonia is characterized by structural alterations of certain defined anatomical elements of the lungs; malarial fever is characterized by certain definite lesions of the blood, liver and spleen; yellow fever, by certain lesions of the blood, heart, liver and kidneys; typhoid fever, by certain lesions of the intestinal canal: in each case, the important question arises, what is the exact connection between the local lesions or manifestations of diseased action, and the general pyrexiæ.

If in Pneumonia, the exudation into the lungs coincides with the end of the pyrexiæ, it would appear that the exudation into the air cells, relieved or cured the fever; and the conclusion might be justified, that the lung disease is not a primary but secondary affection, and that by purifying the blood, it brings to an end, a condition of general pyrexiæ, arising from preceding blood disease. On the other hand, it may be held that the local inflammation of the lung is the primary lesion, and the fever is the result of the disturbances in the blood circulation and nervous system caused by the inflammation of certain anatomical elements of the pulmonary tissue. I do not propose to enter into an exhaustive discussion of these theories, which would demand even greater space than that devoted to the consideration of Traumatic Tetanus; and will dismiss the subject with the practical observation, that as a general rule, the fever is coincident with the supervention of the local inflammation, and presents characters in accordance with its extent and severity, and continues as long as active inflammation is present, and is renewed in intensity whenever fresh portions of the pulmonary tissue are involved. According to this view the fever of Pneumonia resembles the traumatic or so-called surgical fever attending wounds.

In the Dietetic System, which consists in allowing the disease to run its natural course uninfluenced by drugs; during the active stages, the diet is light, with cold water for drink; and subsequently when the fever and active symptoms decline, a more generous diet is allowed, with alcoholic stimulants if the forces are depressed.

Dr. Dietl treated 380 cases of primary pneumonia, in the Charity Hospital of Vienna, by Venesection, by large doses of Tartar Emetic, and by diet alone, with the following results:

In 85 cases of Pneumonia treated by Venesection, 17 died, giving 20 per cent. of deaths, or *one* death in *five* cases.

In 106 cases treated by large doses of Tartar Emetic, 22 died, giving 20 per cent. of deaths; or one death in 4.818 cases.

On the other hand, in 189 cases treated by diet alone, only 14 died, giving 7.46 per cent. of deaths, or 1 death in 13.5 cases.

In the experiments of Dr. Dietl, the superiority of the treatment by diet, was rendered still more obvious, by the fact, that of 85 cases treated by diet, not one of the deaths was uncomplicated.

According to Dr. George Balfour, who examined the statistics of the Homœpathic Hospital of Vienna, many severe cases of Pneumonia recovered under a form of treatment which consisted in little else than to allow the disease to run its natural course, under certain regulations of diet.

In the expectant plan of treatment, adopted by Skoda, in the Charity Hospital of Vienna, in which remedies were given to meet occasional symptoms, venesection being practiced early if there was much dyspnœa, opium administered if there was much pain, and emetics given if the expectoration was difficult and the mucus tough, during a period of three years and five months, commencing 1843, 393 patients were treated, of whom 54 (13.77 per cent.) died, or one death in 7.25 cases.

The comparison of these results would seem to indicate that the mortality was in a great measure proportional to the interference with the operations of nature by venesection and drugs.

It is important, however, that these experiments should be greatly extended, and careful records kept of the phenomena manifest during the various stages of the disease. The points of chief interest to be noted by the investigator are:

1st. The precise time and symptoms of the commencement of the disease.

2d. Hourly and daily variations of the pulse, respiration and temperature.

3d. Chemical constitution and pathological changes of the blood.

4th. Chemical constitution, and pathological changes, and daily variations of the urine.

5th. Microscopical and chemical composition and variations of the sputa.

6th. Careful observations on the various stages of the disease, which mark the progress to recovery or to death. All critical discharges from the skin, lungs, kidneys and bowels should be carefully noted, as well as the attendant variations of temperature, and of the circulatory and respiratory acts.

7th. In fatal cases, careful miroscpical and chemical examinations should be made of the diseased structures.*

II. RATIONAL TREATMENT DESIGNED TO FURTHER THE NATURAL PROGRESS OF PNEUMONIA TOWARDS RECOVERY.

This mode of treatment should evidently embrace the Dietetic System, and, although resembling in some respects the Expectant plan, differs from it, in that it is an attempt to treat disease by fixed principles, rather than according to casual symptoms, the design of the remedies being to excite and aid those natural processes by which the disease terminates favorably. However imperfect this system may now be, in comparison to its possible improvement, still it is not too much to affirm that the principle which underlies it, viz: the adaptation and conformation of treatment to the processes which nature herself employs in the cure of disease, rests upon a firm foundation.

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* Dr. Parkes, Emeritus Professor of Clinical Medicine in University College, has given a valuable record of an uncomplicated case of Pneumonia, unmodified by any other disease or by treatment. Med. Times and Gazette, Feb 25th.

The principles of this system of treatment date as far back as Hippocrates; many of the subsequent writers on Medicine, however, have lost sight of the powers of nature in the cure of disease, and it is only within comparatively modern times that the necessity of conforming the treatment of disease to the processes of nature in the cure of disease, has been recognized by at least a respectable portion of the medical profession.

It would perhaps be of some interest to introduce here, for purposes of comparison, the views of those authors who have endeavored to establish the treatment of pneumonia upon fixed principles; but as a large proportion of the systematic writers who have exerted a decided influence upon the practice of medicine, have not only entertained notions upon the nature and relations of the phenomena of inflammation, necessarily imperfect, from the state of physical diagnosis, as well as of pathology, at the time of the composition of their works, but have also failed to give any data by which a comparison might be instituted as to the relative merits of their modes of treatment, we will, under this division of our subject, confine our examination to the views and testimony of only two modern writers, who may be taken as fair exponents of the Rational System of treatment, and who have furnished data by which the merits of the system may be tested, with some approach to accuracy.

The treatment which Dr. John Hughes Bennett pursues in Pneumonia, is founded on the pathological principles, never to attempt cutting the disease short, nor to weaken the pulse and vital powers, but, on the contrary, to further the necessary changes which the exudation must undergo, in order to be fully excreted from the economy. To this end, during the period of febrile excitement, Dr. Bennett contents himself with giving salines in small doses, with a view of diminishing the viscosity of the blood. As soon as the pulse becomes soft, beef tea and nourishment are ordered; and if there be weakness, from four to eight ounces of wine daily. As the period of crisis approaches, a diuretic is given, generally consisting of half a drachm of Nitric Æther, sometimes combined with ten minims of Colchicum Wine, three times daily, to favor the excretion of urates. But if crisis occurs by sweat or stool, care is taken not to check it in any way.

Dr. Bennett gives as the results of this practice during eight years, in the clinical wards of the royal Infirmary:

Total number of cases treated, 78; average age 30⅔; of these, 75 were dismissed cured, and 3 died; that is, one death in twenty-six cases. Of the 75 cases cured, 65 were uncomplicated, and 10 complicated. Average duration of single, uncomplicated Pneumonia, 14¼ days. Average duration of double uncomplicated Pneumonia, 20 days. The fatal cases were all complicated. The first with uncontrollable diarrhœa, and on dissection conjoined with Pneumonia, there was found extensive follicular disease of the mucous membrane of the duodenum, jejunum, but chiefly of the ileum. The second case was complicated with persistent albuminuria and anasarca. No post-mortem examination could be obtained. The third case, that of a drunkard, was complicated with delirium tremens, and lately violent convulsions. On dissection, in addition to the Pneumonia, there was found universal cerebral meningitis, with exudation at the base, as well as over both hemispheres of the brain.

From the results of his treatment, both with and without blood-letting, and from a comparison of the results obtained by other practitioners, Dr. Bennett concludes: "That uncomplicated Pneumonia, especially in young and vigorous constitutions, almost always gets well, if, instead of being lowered, the vital powers are supported, and the excretion of effete products assisted. It is exactly in these cases, however, that we are formally enjoined to bleed most copiously, and that our systematic works even now direct us to draw blood largely and repeatedly, in consequence of the supposed imminent danger of suppuration destroying the texture of the lung. Such danger is altogether illusory, and the destruction of the tissue, so far from being prevented, is far more likely to be duced by the practice. In fact, the only cases in which it occurs, are in aged or enfeebled constitutions, in which nutrients, and not antiphlogistics, are the remedies indicated. We can, however, readily understand how blood-letting, practiced early, and in young and vigorous constitutions, does less harm, or, to use a common expression, 'is borne better,' than when the disease is advanced, or the patient is weak, and this because then the vital powers are less affected by it. Hence the diminished mortality in the second series of Louis' cases, and probably in the army and navy cases. But that it cures the greater number of persons attacked, or shortens the duration of the disease, is disproved by every fact with which we are acquainted." (Clinical Lectures on the Principles and Practice of Medicine, by John Hughes Bennett, M. D., F. R. S. E., Professor of the Institutes of Medicine, and Senior Professor of Clinical Medicine in the University of Edinburg. Third Edition; Edinburg, 1859; pp. 292–295).

Doctor Robert Bently Todd, in a Clinical Lecture delivered in July, 1857, thus presents his views of the Treatment of Pneumonia:

> "A principal, and very important part of the treatment, to which, as most of you know, I pay very especial attention, is that which I may call the dietetic portion. The object of this is to support the vital powers of the patient, and to promote general nutrition during the time when those changes are taking place, which tend to check or alter the morbid process, and to convert it into a healing process. When a patient suffers from Pneumonia, the tendency is for the lung to become solid, then for pus to be generated, and at last, for the pus-infiltrated lung-structure to be broken down and dissolved. Such are the changes when matters take an unfavorable course. On the other hand, recovery takes place, either through the non-completion of the solidifying process, or by the rapid removal, either through absorption, or a process of solution and discharge of the new material which had made the lung solid.
>
> "It will scarcely be affirmed, even by the most ardent believer in the powers of therapeutic art, that any of the measures which are ordinarily within our reach, such as the administration of certain drugs, or the abstraction of blood, or the application of blisters, exercise a *direct* influence in effecting these changes. Save in the case of antidotes, which directly antagonize the proximate cause of the morbid state, medicines promote the cure of acute disease, by assisting and quickening some natural curative process. And he is the wisest practitioner, and will be the most successful therapeutist, who watches carefully the natural processes of cure—in other words, who studies the phenomena, both anatomical and physiological, which accompany them, and of which, indeed, they consist."
>
> You will perceive, then, that my argument may be thus summed up: Internal Inflammations are cured, not by the ingesta administered, nor by the egesta promoted by the drugs of the physician, but by a natural process, as distinct and definite as that process itself of abnormal nutrition, to which we give the name of inflammation. What we may do by our interference, may either aid, promote, and even accelerate this natural tendency to get well, or it may very seriously impair and retard, and even altogether stop that salutary process.
>
> If then, this view of the nature of the means by which inflammation is resolved in internal organs be correct, it is not unreasonable to assume, that a very depressed state of vital power, is unfavorable to the healing process. Indeed, if you watch these cases in which nothing at all has been done, or in which nothing has been done to lower the vital powers, you will find that the more inflammatory process itself, especially in an organ so important as the lung, depresses the strength of the patient more and more.
>
> You will perceive, then, that according to these views, there are strong *a priori* reasons in favor of the policy of upholding our patients, even in the earliest stages of acute disease, by such food as may be best suited to the digestive organs, such as is most readily assimilated and calls for the least effort, the smallest expenditure of vital force, for its primary digestion. Nutritive matter in a state of solution—broths, soups, farinaceous matters—answers the purpose the best; and, also, alcohol, which is directly absorbed, without any previous change, and tends to feed the Calorifacient process, and to diminish the waste of tissues, which would necessarily follow in order to maintain it.
>
> Inflammation is a deranged nutrition. Like the normal nutrition, it involves supply and waste, and as the latter is considerable, the former will be proportionally so. The tendency, in inflammation, is to the more or less rapid formation of abnormal products such as lymph and pus; and the supplies for these formations must be drawn from the blood, or from the tissues, in both cases, with the effect of more or less exhaustion of vital force; in the latter, with more less extensive organic disintegration. The active chemical procsss which accompanies all these changes engenders the great heat of the inflamed part."
>
> The more this process of inflammation draws upon the blood, the greater will be the exhaustion of the vital force, and the more the whole frame will suffer: the more it feeds on

> the tissues, the greater will be the difficulty of the reparative process. Is it not, then, important that adequate supplies should be conveyed to this process, abnormal though it be? And is it not likely that the most appropriate supplies may be conveyed to it through the blood, so that the waste of tissue may be stopped, and the tendency to abnormal formations be checked, at least, from that direction?
>
> And this, in truth, seems to me, to be but the plain and simple fact;—you must feed inflammations as you would other active vital processes. You must, that is feed them to prevent them from extending to, and preying upon, healthy organic structures and committing great destruction. Bear in mind, too, that you cannot stop an inflammation, so long as the exciting cause of irritation is inherent in the inflamed part; you cannot cure an inflamed eye so long as the irritating particle of dust remains adherent to it. It is wise then, to try and gain time, until, by antidotal means, or by elimination, you can get rid of the local irritation, whatever that may be.
>
> This is a fact which I have so often verified, that I am able to enunciate it dogmatically, that alcohol carefully administered from an early period, in small and often repeated doses, is the best preventive of, and antidote to, delirium in acute disease. This fact, as regards the influence of alcohol in the prevention of delirium, is one of the most important which the clinical observation of cases treated by stimulants brings out. It is quite inexplicable by those who refuse to study the action and mode of digestion of alcohol, and who, adhering to old prejudices, rest content with a practice under which, to say the least, great mortality occurs, rather than be at the trouble of carefully investigating the powers of an important remedial agent. * * *
>
> Rapidity of convalescence is not the least inportant feature of the cases treated by the upholding plan. Once the acute mischief is subdued, it is surprising with what rapidity the patient emerges from the invalid condition.*

In his "Clinical Lectures on Acute Diseases," published a little more than two years after the lecture from which we have just quoted, Dr. Todd advocates the same general plan of treatment in Pneumonia. In the lectures devoted to the consideration of Pneumonia, Dr. Todd recommends the plan of treatment which consists, not in the use of remedies directly antiphlogistic so-called, that is, of remedies intended directly to knock down inflammation by withdrawing blood, the supposed fuel of all inflammation, and reducing vital power, but in the employment of means which will promote the free exercise of certain excretory functions, by which the blood may be purified, and certain matters removed from the system, which, remaining in it tend to keep up a state favorable to inflammatory affections. The remedies used, tend to promote the free action of the skin and kidneys, and in a less degree, that of the intestinal mucous membrane, whilst at the same time, a free stimulation is maintained of that part of the skin which is near the seat of the pulmonary inflammation; and an essential part of the treatment is, that while the remedies are being used, no attempt is made to reduce the general powers of the system, but they are, on the other hand, upheld by frequent and duly apportioned supplies of easily assimilated nourishment, to supply the waste, which, during the inflammatory process, must necessarily take place in the most important tissues of the body, especially the muscular and nervous. The general treatment consists in free counter-irritation, by the application to the back, and side, and over the region of dullness, of flannels soaked in warm Spirits of Turpentine, kept on for about half an hour, and generally applied at three periods of the day, for three or four days. A diaphoretic medicine is administered, consisting chiefly of the Liquor Ammoniæ Citratis, of which as much as six drachms may be given every three or four hours; an occasional dose of a mild aperient medicine may be given, and for food, the patient is allowed at least a pint of beef tea daily, with milk and bread. If the pain is severe, opium may be given in moderate quantities, but usually it is not advisable to employ opium in large doses in the simple forms of Pneumonia, because it has some tendency to produce further congestion of the lungs, and to depress the heart. Every influence of a depressing nature, should be counteracted as far as possible; and although the exhibition of stimulants does not form a *necessary* part of the plan of treatment, still they should be used whenever necessary to uphold the patient's strength. When the vital powers are clearly himself remarks, that the facts which he has collected, are neither so numerous nor so varied, that the result can be considered henceforth as established laws.

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* Remarks upon the Treatment of Acute Internal Inflammations (an extract from a Clinical Lecture delivered in July, 1857), by R. B. Todd, M. D., F. R. S., Physician to King's College. Archives of Medicine, edited by Lionel S. Beale, M. D., No. 1, pp. 2, 4. No. 2, pp. 53, 55, 57, 58.

The second series of cases of Pneumonitis observed by Louis at the hospital la Pitié numbered 29, of which 4 proved fatal, or one death in 7.25, or 13.79 per cent.

Louis states that the total number of cases of Pneumonitis which came under his treatment during four years at this hospital, was one hundred and fifty, and that blood-letting, although usually carried to a greater extent than was practicable in his first series of observations at the la Charité, oftimes to the extent of 20 to 25 ounces and more, or even to syncope had not been more decidedly successful, and in no case was inflammation arrested by its use. He expressed his belief that practitioners have been misled in believing it possible to arrest pneumonitis at its onset, by large bleedings, from having observed that in some cases, rare indeed, the bleeding is followed by a considerable amendment in the general, and in some of the local symptoms, pain and dyspnœa. But the other phenomena remain, and are even augmented in intensity and extent after the first blood-letting; if this has been practiced soon after the commencement of the disease, and if then the patient is not accurately examined, the practitioner believes that the disease is arrested, when in fact there is only a diminution of febrile action and some other symptoms. Whilst stating thus decidedly his experience from memory, he confines his analysis of the effects of blood-letting in the second series only to 29 cases. As in the first series of cases, the patients were in excellent health when the first symptoms of pneumonitis appeared, and not a doubt was entertained as to the character of the disease which affected them, all having expetorated rusty, viscid, semi-transparent sputa; and all having had to a greater or less extent, crepitous rale, bronchial respiration and broncophony, with more or less dullness on percussion in the corresponding part.

In his effort to find some explanation of the differences in the degree of mortality, in the two series of cases, Louis does not attribute it to age, for the difference in this respect was in favor of the patients of the la Charité, whose mean age was forty and that of the others forty-three; nor were the cases in which early blood-letting was employed more numerous in proportion, at la Pitié than at la Charité, nor can the difference of mortality be imputed to the difference of seasons at which the patients came under observation. Louis accounts for the fact by differences in treatment, the patient at la Pitié being bled less frequently, but more copiously, and antimony was used more freely with them. Antimony was administered in increasing doses, from 6 to 12 grains in six ounces of the distilled water of the lime tree flowers, sweetened with half an ounce of syrup of poppies; and the patient took this in the course of the day, in six or eight doses. Out of 20 patients in a hazardous condition, to whom antimony was given, only three died. The treatment of the patients at la Charité was farther different from that of la Pitié, in this respect, that vesication was employed at the former and not at the latter hospital. At the Hospital of la Charité, blisters were not applied in all the cases which terminated favorably but only where bleeding was so ineffectual that fears were entertained for the result. Vesication was used, in one half of the cases, or in twenty-five patients, whose first blood-letting was during the first four days of the disease, or later; and the average length of the disease in these cases was twenty-two days two hours; while it was fifteen days and eight hours only, in the other cases. An enormous difference, which would seem to show that the unfavorable conditions under which blisters were used, have not been sensibly affected by their action; and Louis therefore infers that the vesication was valueless. Louis farther declares that he had not only rejected vesication in the treatment of pneumonitis; but had also ceased to employ it in pleurisy and pericarditis; and one hundred and forty cases of pleurisy treated during 5 years at la Pitié without vesication in a single instance, all recovered. The reasons which [illegible] Louis to reject vesication from the treatment of acute thoracic inflammation are [illegible] of careful examination by the profession. This accurate observer, informs [illegible]ond series of observations upon the effects of blood-letting, that an atten[illegible] and rigorous [illegible] of the facts forced him to acknowledge that acute [illegible] affections [illegible] in preserving from inflammation, organs which are not the primitive seat of disease, are in truth, an exciting cause of inflammation; insomuch that the more severe the primitive inflammatory affection, and the more considerable the accompanying fever, the more are the secondary inflammations to be dreaded. And how then, asks Louis can we believe that the effect of a blister, is to check an inflammation when this blister is one inflammation superadded to another? And whilst he admits that this is reasoning only by analogy, and whilst he does not advocate the abandonment of blisters in every case, he affirms that one thing is assuredly beyond question and we should never be weary of repeating it; that the therapeutic value of blisters is not known; that it must be studied by the aid of numerous and carefully noted facts, just as if nothing at all were known about it.

The total number of cases upon which Louis bases his researches upon blood-letting is 107, and of these 32 died, or one death in 3.34 cases, or 29.94 per cent.

The results of the researches of Doctor James Jackson, the able American editor of the works of Louis, upon 34 cases of Pneumonia in the Massachusetts Hospital, corresponded as far as they extended, closely with the results just presented. In the Massachusetts General Hospital, Dr. James Jackson, treated during a period of four years, from December 3d, 1831, to December 3d, 1835, 51 cases of Pneumonia, with a mortality of 8 deaths, or one death in 6.37 cases, or 15.68 per cent. These cases were treated strictly upon the antiphlogistic plan, with repeated blood-letting, cathartics, tartar emetic, and opium, in many cases, mercurials and colchicum. The mercurials were used in small doses, and generally in combination with opium, and their influence was never pushed beyond a slight soreness of the gums. The Colchicum (C. Autumnale) sometimes the root, and sometimes the seed, was used in the manner and upon the principles laid down by Mr. Haden, of London, in his treatise on this article of the Materia Medica. It was given in aid, or as a substitute for blood-letting, in such doses as to induce nausea at least, and usually vomiting and purging; and then continued in such doses, as could be borne by the patient without much inconvenience. The Tartarized Antimony was used after the manner recommended by Odier, in Geneva, in practical medicine:—a solution of the Tartarized Antimony was made of such strength that every fluiddrachm contained a quarter of a grain of the mineral; at first half a drachm or a drachm is administered, but each succeeding dose was increased by half a drachm or a drachm, until nausea, vomiting or purging is induced. As soon as either of these occurred in an inconvenient degree, the dose was reduced to such a quantity as the patient could conveniently bear; or the medicine was suspended, till the operative effects had ceased, and then recommenced in a smaller dose. The sensible effects of this medicine and the colchicum were very similar, as well as the appearance of temporary relief which they induced.

Andral advocated bleeding strenuously, and enforced in his practice the principle laid down by Galen, sixteen centuries before, that we should have recourse to bleeding, whatever was the day of the disease, aye: even if it were the twentieth, every time it was indicated. Andral records in his Clinique Medicale, 65 cases of Pneumonia treated by blood-letting at all stages, even in the third stage, and by Tartar Emetic in doses of from 6 to 32 grains in the twenty-four hours, continued for several successive days; and of this number of cases thus energetically treated, 36 or more than one-half, died.

According to Dr. Hughes Bennett, between the years 1812 and 1837, there were treated in the Royal Infirmary of Edinburgh, 103 cases of Pneumonia, by the antiphlogistic plan of treatment, and of this number 41 died. When all incomplete and doubtful cases were rejected from the list, and only those retained which were manifest cases of Pneumonia, or acute inflammations of the chest closely allied to that disease, the result was that in 50 cases, 19 died; or one death in 2.63 cases, or 38 per cent. And according to the same author, in this Institution, from July 1st, 1839, to October 1st, 1849, 648 cases of Pneumonia were admitted, and 222 proved fatal, or one death in 2.91 cases, or 34.26 per cent.

M. Grisolle, whose plan of treatment was similar to that of Louis, with this difference that he advocated more moderate bleedings, reports 37 deaths in 232 cases occurring in his hospital practice, or one death in 6.27 cases, or 13.9 per cent. In like manner with the cases reported by Louis, those bled the most exhibited the highest mortality.

The method of treating Pneumonia, by large doses of Tartar Emetic, as advocated and introduced into general practice by Rasori, about seventy years ago, (although many other physicians, as Paracelsus, Huxham, Pringle, Cullen, Mauyat and others, had recommended Tartar Emetic in the treatment of fevers and other diseases, still there appears to be no dissent from the view that it is to the Italian Physicians, and especially to Rasori, that the practice of medicine is indebted for the revival of this practice, and the introduction of this drug in large doses, as a cure for inflammatory diseases) although yielding results apparently from the statistics which have been published more favorable than those by copious blood-letting, are still by no means uniform; and in the Southern States many practitioners have abandoned the use of this remedy in Pneumonia, especially in the large doses recommended by the Italian physicians, on account of its depressing effects upon the forces, and its frequent injurious action upon the bowels. As far as my knowledge extends, the Southern country affords no statistics by which the relative value of this remedy may be determined. It is certainly a subject of interesting and important investigation to determine whether Tartar Emetic would be more injurious in malarial, than in elevated, healthy, non-malarious districts.

Rasori employed this medicine, so as to obtain its full effects. After one or more bleedings, but sometimes without this measure, from 12 to 24 grains, or in severe advanced cases 20 to 30 grains were given during the day, and the same quantity repeated in the night; and these doses were daily increased until they amounted to a drachm or even several drachms in the twenty-four hours. Out of 832 cases of Pneumonia treated by Rasori in this way, 173 died; or one death in 4.8 cases, or 20.79 per cent. The mortality differed somewhat in the military and civil hospitals; thus it was fourteen per cent. in the former and about twenty-two per cent. in the latter.

The success of Tommasini with this remedy, conjoined with bleeding, was much greater; thus he states, that out of 115 cases of Pneumonia, only 14 died; or one death in 8.21 cases, or 12.17 per cent.

The celebrated Laennec employed Tartar Emetic with marked success in the treatment of Pneumonia. The following is his method, together with his testimony to its therapeutic value in comparison with other modes of treatment.

“As soon as I recognize the existence of the Pneumonia, if the patient is in a state to bear venesection, I direct from eight to sixteen ounces of blood to be taken from the arm. I very rarely repeat the bleeding, except in the case of patients affected with disease of the heart, or threatened with apoplexy or some other internal congestion. More than once, I have even affected very rapid cures of intense peripneumonies without bleeding at all; but in common, I do not think it right to deprive myself of a means so powerful as venesection, except in cachectic or debilitated subjects. In this respect Rasori does the same. I regard blood-letting as a means of allaying for a time the violence of the inflammatory action, and giving time for the tartar emetic to act. Immediately after bleeding, I give one grain of the tartar emetic, dissolved in two ounces and a half of cold weak infusion of orange-leaf, sweetened with half an ounce of syrup of marsh-mallows or orange flower; and this I repeat every second hour, for six times, after which I leave the patient quiet for seven or eight hours, if the symptoms are not urgent, or if he experiences any inclination to sleep. But if the Pneumonia has already made progress, or if the oppression is great, or the head affected, or if both lungs or one whole lung is attacked, I continue the medicine uninterruptedly, in the same dose, and after the same intervals, until there is an amendment, not only in the symptoms, but indicated also in the stethoscopic signs. Sometimes even, particularly when most of the above mentioned unfavorable symptoms are combined, I increase the dose of the Tartar Emetic, to a grain and a half, two grains, or even two grains and a half, without increasing the quantity of the vehicle. Many patients bear the medicine without being either vomited or purged. Others, and indeed, the greater number vomit twice or thrice, and have five or six stools the first day; on the following days they have only slight evacuations, and often indeed have none at all. When once *tolerance* of the medicine (to use the expression of Rasori) is established, it even frequently happens, that the patients are so much constipated as to require clysters to open the body. When the evacuants are continued to the second day, or

reason to fear on the first, that the medicine will be borne with difficulty, I add to the
to be taken in the twenty-four hours, one or two ounces of the syrup of poppies.
bination is in opposition to the theoretical notions of Rasori and Tomasini, but has
ved to me by experience to be very useful. In general, the effect of Tartar Emetic is
re rapid or more efficient than when it gives rise to no evacuations; sometimes,
its salutary operation is accompanied by a general perspiration. Although copious
nd frequent vomiting are by no means desirable, on account of the debility and the
ritation of the intestinal canal which they may occasion, I have obtained remarkable
ases in which such evacuations have been very copious. I have met with very few
neumonia, where the patient could not bear the Tartar Emetic; and the few I have
occurred in my earliest trials, insomuch that this result now appears to me to be
le rather to the inexperience and want of confidence of the physician than to the

requently find, that a patient who bears only moderately six grains with the syrup
s, will bear nine perfectly well on the following day. At the end of twenty-four or
t hours at most, frequently even after two or three hours, we perceive a marked
ent in all the symptoms. And sometimes even, we find patients, who seem doomed
death out of all danger after the lapse of a few hours only, without even having
ed any crisis, any evacuation, or indeed any other obvious change, but the rapid and
e amelioration of all the symptoms. In such cases the stethoscope at once accounts
dden improvement, by exhibiting to us all the signs of the resolution of inflammation.
iking results may be obtained at any stage of the disease, even after a greater por-
e lung has undergone the purulent infiltration. As soon as we have obtained some
ion, although but slight, we may be assured that the continuation of the remedy
t complete resolution of the disease without any fresh relapse; and it is in regard to
, more particularly, that the greatest practical difference between the tartar emetic
l-letting consists. By the latter measure, we almost always obtain a diminution of
of the oppression and the bloody expectoration, so as to lead both the patient and
dants to believe that recovery is about to take place; after a few hours, however,
orable symptoms return with fresh vigour; and the same scene is renewed, often five
es after as many successive venesections. On the other hand, I can state that I
r witnessed these renewed attacks under the use of Tartar Emetic. In these cases
e only in the progress towards convalescence, occasional stoppages. And this is
icularly the case, in respect to the stethoscopic signs; as we find that between the
en the patient experiences a return of his appetite and strength, and fancies himself
ed, and the period at which the stethoscope ceases to give any indication of pul-
gorgement,—more time frequently elapses than between the invasion of the disease
ginning of convalescence. It is necessary to observe, however, that this remark is
frequently applicable to the disease, when treated by blood-letting; and moreover,
atients subjected to the antimonial method, never experience the long and excessive
hich too often accompanies the convalescence of those who had been treated by
enesections.

t way of appreciating any particular mode of treatment, is by its results. I am
y that I only began last year to keep an exact account of the results of wine by
tic; but I can affirm that I have no recollection of death from acute pneumonia in
hen this medicine had been taken long enough for its effects to be experienced. I
witnessed a few fatal terminations, when the case was slight peripneumony, com-
ith severe pleurisy. I have, also, lost some patients, who, besides the pneumonia,
ted with cancer, phthisis, disease of the heart, etc.; and these were the cases where
pportunity of observing the different degrees of resolution in this disease. Finally
t some who were brought to the hospital, moribund, and who sunk before they had
e than two or three grains of the remedy. In the year 1824, at the Clinic of the
Medicine, I treated by the tartar emetic, twenty-eight cases of pneumonia, either
complicated with slight pleuritic effusion. Most of these cases were very severe,
ere all cured, with the single exception of a cachectic old man of seventy, who took
of the medicine, because he bore it badly. During the present year (1825), I have
irty-four cases in the same manner. Of these, five died: but, of this number, two
ne aged fifty-nine, and the other, sixty-nine—were brought to the hospital mori-
sunk before they had taken more than two or three doses of the emetic tartar; a
of disease of the heart, when convalescent from the pneumonia; and a fourth fell
o chronic pleurisy, also in the period of resolution of a sub-acute pneumony. These
ases will be detailed hereafter. The fifth case was that of a man seventy-two years
ho died of cerebral congestion, on the tenth day of the disease. Of these five cases,
first two cannot be adduced in either way as instances of the effect of this remedy;
ext two are proofs of its efficacy in *pneumonia*, rather than the contrary.

ult, therefore, of the whole is, that of fifty-seven cases of pneumonia treated by the tartar emetic, only two individuals, both upwards of seventy, died of this disease, conjoined with cerebral congestion,—that, is a little less than one in twenty-eight. In private practice, during the last three or four years, I have not been called in consultation to cases of acute pneumonia, or to cases uncomplicated with violent pleurisy, except such as appeared already threatening a fatal termination; and yet I do not remember a single case which proved fatal under the use of the emetic tartar, except that of a plethoric subject aged seventy-two. * *

The above results of my practice are more favorable than those of Rasori's lately published [Reveu Med., Mar. 1825]. This may be owing to two causes: first, because auscultation enables us to ascertain the existence of peripneumony much quicker than we could do from the ordinary symptoms; and, secondly, because, in all probability, many cases of simple pleurisy, or of pleuro-peripneumony with predominence of pleurisy, are comprehended by Rasori, under the name of *peripneumony*,—it being impossible to discriminate these different affections from each other, without the aid of auscultation. I have already stated that we must not expect equally favorable results in the treatment of pleurisy, as in the treatment of pneumonia, by the tartar emetic.

My cousin, Dr. A. Laennec, physician of the Hotel Dieu, of Nantes, has treated with the tartar emetic, during the last two years, forty cases of the pleuo-pneumonia. Of these six proved fatal, three in consequence of errors of regimen during convalescence. Substracting these, then, the proportion of deaths will be one in thirteen.* Dr. Hellis, of Rouen, has lately presented to the Royal Academy of Medicine, a Memoir on the Treatment of Pneumonia, after the method of Riverius and Stoll, that is by repeated emetics.† Of forty-seven cases treated by him, he only lost five, being a proportion of somewhat less than nine. This result although much less favorable than that which has followed the use of tartar emetic in large doses, in my practice, is yet more so than that obtained from the employment of blood-letting and diruetics, which I have stated to be one in six or eight." (A Treatise on the Diseases of the Chest, and on Mediate Auscultation, by R. T. H. Laennec, M. D. Translated by John Forbes, M. D. S., New York, 1830, pp. 255, 261.)

M. Peschier and Dr. Gentile' of Naples, and many other Italian physicians, Dr. Balfour, of Edinburgh, Dr. Wolff, of Warsaw, Drs. Wesener, Brughart, Forbes, Graves, Stokes, and many others, in France, Germany and England, have employed the Tartar Emetic method, after the method of Rasori, in the treatment of Pneumonia, with great success. On the other hand, Wagner states, that out of 13 cases of Pneumonia treated according to this method, seven, or more than one-half died—victims, according to his belief, more to the practice than the disease. We have before given the testimony of Drs. Todd and Bennett against this remedy.

With reference to Calomel and Opium, in the treatment of Pneumonia, we are unacquainted with any statistics by which the value of these remedies may be determined, comparatively at least. The same remark applies to the Veratrium, so popular as a remedy in Pneumonia in certain portions of the South. Calomel and Opium have been almost universally employed, in conjunction with other more energetic remedies, as bleeding and Tartar Emetic. They are, without doubt, agents of great power, which have been used, in many cases, with as much detriment as good. Whilst, judiciously used, Opium exerts a most salutary effect upon the progress of Pneumonia, not only in easing pain and promoting sleep, often so essential to the comfort, and sometimes even to the life of the patient, but also in promoting free secretion from the skin; it may, on the other hand, when used in large and often-repeated doses, increase the congestion of the lungs. Calomel may, in certain cases, especially in those in which the liver has been rendered torpid by the action of malaria, prove a valuable purgative; but, on the other hand, when used in alterative doses, it may produce mischief, by defibrinating the blood, and prolonging the convalescence. If the increase of fibrin in the blood be a salutary process in inflammation, similar to what takes place in the blood of pregnant women, and for a similar reason, of increased production and development of structure, then, whatever tends to break down the constitution of the blood, and especially the fibrinous element, weakens the reparative process.

It is well known that a change in the treatment of inflammation has been gradually progressing, with at least a portion of the profession. This change is said by its advocates to be the result of increased knowledge of the phenomena of inflammation, as well as of a more thorough knowledge of the relative value of the different methods of treating inflammation. It is incumbent upon the advocates of these changes in the treatment of inflammation, that they should not merely demonstrate the consistency of their principles with the actual operations of nature, but should also illustrate their value and truth by their results, in shortening the course of inflammations, in modifying the injurious effects, and in diminishing the mortality. By a course of careful and extensive experiment, by careful, conscientious and competent observers, in various hospitals, and upon, not hundreds, but upon thousands of cases, positive data will be furnished, by which comparisons may be instituted, between the results of all the methods of treatment. We have, in the preceding pages, furnished many important facts bearing upon the determination of the relative merits of the different modes of treatment, and have endeavored to classify them, so as to facilitate future research, but it must be confessed, that much remains to be accomplished, in subjecting the various remedies popular with the profession in ancient, as well as in modern times, to a rigorous numerical experiment and analysis. The wisdom and practical experience of the older physicians should not be lightly cast aside; and in the present tendency to abandon blood-letting and the more vigorous antiphlogistic treatment, so highly praised in former times, there is danger that we may go too far in the opposite direction, and not only abandon remedies which may be of great value under certain circumstances, but also forget the services rendered by some of the older writers. Thus, the doctrine, that inflammation is a reparative process of nature, and that it should be studied and treated as a modification of the natural processes concerned in the preservation of the body, appears to be but a revival of the doctrines taught by the celebrated John Hunter, who considered inflammation as

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*Jour. de la Sect. de Med. de la Soc. Acad. du depart. de la Loire infer. 1825,

† This Memoir has since been published by the Author, under the title "Clinique Medicale de l'Hotel Dieu, Rouen, Premiere Annee, Paris, 1826.

> "Only a disturbed state of parts, which require a new, but salutary mode of action to restore them to that state wherein a natural mode of action alone is necessary." From such a view of the subject, Hunter concluded that "inflammation, in itself, is not to be considered as a disease, but as a salutary operation, consquent either to some violence or some disease."

The division of inflammation into "healthy" and "unhealthy," by Hunter, and his clear exposition of the dependence of the character and progress of the inflammation upon the condition of the constitution and natural powers of the system, are still further proofs of his recognition of the great principle which underlies all correct knowledge and practice in this process.

The question also, whether there be an actual decrease or increase of power in the system during inflammation, which is now engaging the attention of eminent physicians, and which is so intimately connected with the value of blood-letting and the antiphlogistic remedies, recently discussed with so much ability by Drs. Bennett, Alison, Watson, Bell, Christison, Easton, Kennedy, Markham, Balfour, and other English physicians, evidently engaged the careful consideration of Hunter.

In his "Treatise on the Blood, Inflammation, and Gun-shot Wounds," Hunter thus states the question:

> "Whether the disposition for inflammation, and the change produced in the blood, arise from a real increase of animal life, or whether it is only an increase of a disposition to act with the full powers which the machine is already in possession of, is not easily determined; but it appears to be certain that it is either the one or the other. There are some circumstances, however, that would incline us to suspect it to be the latter, because there is often inflammation when the powers of the machine are but weak, where it appears to be only an exertion of very weak powers, arising from some irritation produced." * * *

Again, in treating of the methods of resolution by constitutional means, Hunter thus defines the principles which should govern blood-letting and the administration of antiphlogistic remedies:

> "When I described inflammation, I observed there was either an increase of life, or an increased

disposition to use with more violence the life which the machine or part was in possession of; and also that there was an increased size of vessels and of course an increased circulation in the part inflamed, and in the constitution in general. If this theory of the mode of action of the vessels in inflammation is just, then our practice is reducible to two principles, one consisting in removing the cause of that action, the other in counteracting the effect. As to the first, as we seldom know the cause, but only see the effect, except in some specific diseases, for which we have a specific remedy, we do not know with any degree of certainty how to act; but, as to the second, that is the effect, as it is more an object of our senses, we can apply with more certainty our reasoning upon it, for reasoning from analogy will assist us in our attempts. We find, from common observation, that many circumstances in life, as also many applications to parts, will call forth the contraction of the vessels; we are, therefore, from the above theory, to apply such means; and whatever will do this, without irritation, will so far counteract the effect. I have already observed, that wherever there has been a violence committed, or some violent action is going on, there is a greater influx of blood to that part. Lessening, therefore, that influx becomes one mode of relief; for, as the vessels dilate, they should not be encouraged in that action. Although the increased influx is to be considered chiefly as an effect, yet it is to be considered as a secondary cause; and from our ignorance of the immediate cause, it is probably only through such secondary causes that we can produce any effect; and upon these principles most likely rests, in some measure, the method of resolution, for whatever will lessen the power and disposition will also lessen the effect, and possibly then will likewise lessen the force of the circulation.

If the inflammation is attended with considerable action and power, as it were, increasing itself, then the modes of resolution are to be put in practice: the one by producing a contraction of the vessels, the other by soothing or lessening the irritability or the action of dilatation.

The first, or contraction of the vessels, is produced in two ways: one by producing weakness, for weakness excites the action of contraction of the vessels; the other, by such applications as induce the vessels to contract.

1st. The means of producing absolute weakness are bleeding and purging; but the bleeding also produces irritability for a time, and is often attended by a temporary weakness of another kind, viz: sickness. The inconvenience, however, arising from this practice is, that the sound parts must nearly, in the same proportion, suffer with the inflamed, for bringing the inflamed part upon a par with health, the sound parts must be brought much lower, so as to be too low.

2d. The soothing may be produced by sedatives, relaxants, anti-stimulants, etc., such as many soporifics, anodynes, etc.

The first method will have the greatest, the most permanent, and the most lasting effect, because, if it has any effect at all, the diseased action cannot be soon renewed. The second will act as an auxiliary, for so far as irritation is a cause this will also lessen it, and the two should go hand in hand; for whenever we lessen power, we should, at the same time, lessen the disposition to action, or else we may increase the disposition; but neither bleeding, purging nor sickness can possibly lessen the original inflammatory disposition, for none of them will resolve a venereal inflammation when mercury will; nor will they resolve the erysipelatous inflammation, although that inflammation has the very action for which we should bleed in the common inflammation, viz: dilatation of vessels. However, these means may, in some sense, be reckoned direct, for whatever will produce the action of contraction in the vessels is counteracting the action of dilatation. Lessening the power of action belonging to any disposition can only lessen or protract the effects, which, however, will be of singular service, as less mischief will be done, and it will often give the disposition time to wear itself out. Means employed on this principle should be such as give the feel of weakness to the constitution, which will affect the part, and will make the vessels contract; but this practice should not be carried so far as to produce the sense of too much weakness, for then the heart acts with great force and the arteries dilate.

Bleeding, then, as a general principle, is to be put in practice, but this must be done with judgment, for I conceive the effects of bleeding to be very extensive. Besides, the loss of any quantity of blood being universally felt in proportion to the quantity lost, a universal alarm is experienced, and a greater contraction of the vessels ensues than simply in proportion to this quantity, in consequence, as it would appear, of a sympathetic affection with the part bleeding.

Too much blood, in an inflammation, is a load upon the actions of the circulation. Too little produces debility and irritability, because there is loss of powers, with an increased action to keep up which is now not supported. It would seem that violent actions of a strong arterial system required less blood than even the natural actions, and even less still than a weak or irritable system; from whence we must see, that bleeding can either relieve inflammatory action or increase it, and, therefore, is not to be used at random. * * *

However, bleeding should, in all cases, be performed with great caution, more particularly at first, and no more taken than appears to be really necessary. It should only be done to

nstitution or the part, and rather lower it when the constitution is already bled or
low a certain point, or gives the signs of it from the situation of the disease, then
habit takes place, which is an increased disposition to act without the power to
This, of itself, becomes a cause of the continuance of the original disposition, and
will admit neither of resolution nor suppuration, but continue in a state of inflam-
hich is a much worse disease than the former.
were generally given in case of inflammation (probably, at first, from the idea of
to be discharged), and such practice will answer best, when bleeding succeeds,
will lower the body to a more natural standard, and, of course, the inflamed part,
f that constitution; but here the same cautions are necessary that were given upon
because nothing debilitates so much as purging when carried beyond a certain point.
ng stool, shall even kill, when the constitution is very much reduced, as in many
therefore, keeping the body simply open, is all that should be done. However,
purging lowers considerably, yet its effect is not so permanent as bleeding. It
ers action, without diminishing strength; for if a person was to feel the loss of
al to a purge, that sensation would be more lasting. * * *
ble habits, when the inflammation becomes more diffused greater caution is neces-
regard to purging as well as bleeding; for I observed on the subject of bleeding,
ch constitutions, no more blood should be taken than would relieve the constitution,
mechanically, not such a quantity as to have a tendency towards lowering or weaken-
nstitution, for in such cases the action is greater than the strength; and whenever the
n between these two is of this kind, we cannot expect anything salutary from this mode
ent, and therefore should not increase it. In such cases, the very reverse of the
thod should often be practiced: whatever has a tendency to raise the constitution
tability should be given—such as barks, etc. The object of this last practice, con-
inging the strength of the constitution and part, as near upon a par with the action
y, by which means, a kindly resolution or suppuration may take place, according as
inflamed are capable of acting.
es which have the power of producing sickness lessen the action, and even the
wers of life, for a time, in consequence of every part of the body sympathizing with
th; and their effects are pretty quick. Sickness lowers the pulse, makes the smaller
tract, and rather disposes the skin for perspiration, but not of the active or warm
I believe it should proceed no further than sickness, for the act of vomiting is rather
ction to that effect, and produces its effects from another cause, and of course of
nd, which I believe rather rouse. It is probably an action arising from the feel of
and intended to relieve the person from that weakness. It is similar to the hot fit
e, a counteraction to the cold one. There are few so weak; but they will bear
but they cannot bear sickness long. If we had medicines, which when given
could be taken into the constitution, and were endowed with the power of making
s contract, such I apprehend would be proper medicines. Bark has certainly this
and is of singular service I believe in every inflammation attended with weakness,
fore, I conceive, should be oftener given than is commonly done; but it is supposed
rength, which would not accord with inflammations attended with too much
and considerable irritation.
tions of lead given in very small doses, might be given with success in cases attended
t strength. * * The property of lead appears to be that of lessening the powers,
e action; it therefore should never be used but when the powers are too strong, and
with too much violence. However, lead certainly has the power of producing the
n of the vessels; and therefore when there is great strength, lead is certainly a
application." (The Works of John Hunter, F. R. S. with notes edited by James F.
ondon, 1837, vol. i, p. 393; vol. iii, pp. 296, 297, 300, 357, 372, 375, 381, 382, 385.)

vident that Hunter recognized the fact, since demonstrated by Louis, that blood-
nnot arrest inflammation; and it is still farther evident from the confirmation
odern discoveries, and especially the recent experiments upon the sympathetic
system, are giving to his theory of inflammation, and from the philosophical
n which he regulated his principles of practice in accordance with the opera-
nature, as manifested in the character and changes of the blood, and the modi-
of the inflammatory process in different constitutions and under different
nces of life, that the moderns have made but little advance on his principles of
Unfortunately we have no means of determining numerically the success of
practice in different inflammations. From his immense experience, and from
reater observation and judgment, and from the great caution, and from the

inductive method which he employed in determining the action of remed applying them to the relief of disease, and from his high position as a suc titioner in the estimation of the public, as well as of the profession, we believe that the most eminent success attended his practice.

The observations of Conheim and others have rendered it probable that t most important changes, not only of inflammation, but also of Phthisis and to be found in the blood. The discovery of the transmigration of the colorles in inflammation, and the investigation of the changes which they subsequent have not only revolutionized the theories of inflammation, but have tend tablish upon a new basis the long neglected humoral pathology.

CHAPTER XVIII.

ANTIPERIODIC OR ABORTIVE METHOD OF TREATING PNEUMONIA. RELATIONS OF PNEUMONIA TO MALARIA.

Use of Quinine in the treatment of Pneumonia, by Southern Physicians. Observations of Jean Senac, Galeatius, George Cleghorn, Morton, Lautter, Alibert, Laennec, Ramizini, Lancisci, Sydenham, Huxham, Sauvages and Broussais, upon the relations of Malaria and Pneumonia. Investigations of the author on the relations of climate to Pneumonia. Mortuary statistics of Savannah, Georgia; Augusta, Georgia; Charleston, South Carolina; New Orleans, Louisiana; New York and Philadelphia. Cases illustrating the relations of Antecedent Malarial Paroxysmal Fever to succeeding Pneumonia. Effects of the malarial poison upon the blood. Modifications of the phenomena of Pneumonia, induced by the action of the malarial poison on the blood, liver and spleen. Illustrative cases. Practical conclusions deduced from these investigations.

IV. ANTIPERIODIC OR ABORTIVE METHOD OF TREATING PNEUMONIA. RELATIONS OF PNEUMONIA TO MALARIA.

These terms are used, not so much to indicate the true nature of this plan of treatment, as to express the views which have led to its employment by various practitioners in the Southern States.

Southern physicians have, for a number of years, used Quinine in the treatment of Pneumonia; and previous to the recent civil war, a number of articles have, from time to time, appeared in the various medical journals, extolling the virtues of Quinine in the treatment of this disease, and more especially in malarious regions. By many of the advocates of the power of Quinine to greatly modify and even arrest the progress of Pneumonia, the doctrine is held, that the disease arises from the same causes, is intimately associated with Malarial Fever, and, in fact, is nothing more than one of the forms of periodic fever. The remark is not unfrequently heard, that Pneumonia should be treated as a malignant remittent. Those who adopt the view of the identity of paroxysmal fever and Pneumonia, believe that Quinine in full doses, is capable of arresting the latter, in the same manner that it arrests or aborts the former.

We might bring forth numerous quotations from the old writers, to prove that the belief in the identity of the causes and ultimate nature of Pneumonia and paroxysmal fever, as well as the treatment by bark and Quinine, founded upon this view, are by no means so novel as some of the modern writers, and especially American medical writers, would have us believe. Our limited space, however, will permit only brief references to some of the most trustworthy authorities.

Jean Senac,* in his celebrated and unsurpassed treatise on the "Hidden Nature and Treatment of Intermitting and Remitting Fevers," discourses in several chapters upon the conversion of intermittent fever into Pleurisy and Pneumonia; and, in his observations upon the method of detecting or distinguishing intermittents, when disguised under the mask of other diseases, relates a case of Intermittent Pleurisy, cured by febrifuge remedies. Galeatius, near seventy years ago, in a work on Peruvian bark, pointed out the efficacy of this remedy in the cure of Pneumonia, occurring in Intermittent Fever, and which he considered as one of the manifestations of paroxysmal Fever.

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* De Recondita Febrium Intermittentium, tum Remittentium Natura et de earum Curatione: Variis experimentis et observationibus illustrata. 1769.

Jean Senac* advances the theory that Intermitting fevers are due to certain noxious and morbific matter, generated within the body, or introduced from without, which is capable of being diffused throughout the whole system. This matter is particularly hurtful to the Liver; it is accumulated in and exerts its action on that viscus. After the matter has attained a certain state of accumulation and acquired a certain degree of power, it irritates the texture and nerves of the liver, like a foreign stimulus, retards the progress of the blood, and renders that fluid acrimonious and vitiated in its qualities. This matter, by its powerful action on the nerves, throws the whole system into commotion, and is at length, by the fever that ensues, expelled and dissipated as it were, both from the place primarily affected, and from every other part of the system. A fomes, however, may still remain behind, which, gaining strength, by degrees, may produce a recurrence of the same commotions. Sometimes the fomes or active causes of an intermitting fever may be hidden, or may be accumulated in a certain part, so that that part may appear to be the only sufferer; at other times it may give rise to peculiar symptoms, in which the whole force of the disease appears to be centred, and it may even counterfeit other diseases, which pursue a course peculiarly their own, exhibiting no resemblance, and possessing no affinity, whatever, to intermitting fevers. Senac illustrates these views by numerous examples: Sometimes, without any perceptible change in the pulse, the most acute pains take place and return at stated periods; he had frequently observed an excruciating affection of this kind situated above the eye, unaccompanied by any other symptom, the commencement of the pain being, sometimes, attended with a sort of palpitation around the affected part. This author also described a kind of periodical ophthalmia, which uniformly made its attack at stated hours; although an inflammation of this kind does not usually disappear in a short space of time, yet in the affection under consideration, the eye was soon restored to its natural state. Senac met occasionally with cases of excruciating hemicrania, which he considered as the offspring of intermitting fever, or rather which were intermitting fevers converted into hemicrania. The whole head was at times attacked by a pain arising from the same source. In one case, the patient was so dreadfully tormented by a pain of this kind as to be rendered almost insane; at first view, the nature of this affection was not discovered, but on a close examination, it was completely unveiled, for it always made its attack towards noon, raged for a few hours, with great violence, and then remitted. The febrile cause fixes itself not only in the orbit and in the eyes themselves, but also upon the external surface of the head; indeed, it is capable of attacking every part of the system separately. So true is this, that in some patients certain parts seem to suffer from fever, while all the others are exempt from it; some of these parts are periodically affected by a sense of coldness or heat, others by convulsive or tremulous motions, so various are the forms under which the disease appears. But what is not less surprising, pains arising from a febrile cause, yet unaccompanied by any external signs of fever, oftentimes attack the internal parts of the body. This is illustrated by a case in which a very acute pain in the stomach, marked by periodical occurrence, was, at length, cured entirely by febrifuge remedies. This pain was accompanied by no change in the state of the pulse, and no preternatural heat, and during its continuance the functions of all the other parts of the system were unimpaired.

It would consume too much time, and, at the same time, would be only an amplification of the ideas and facts already presented, to follow Senac through his descriptions of the manifold effects of the febrile poison, upon other organs, as the brain, bowels, spleen and liver, and we will close our examination of his remarkable work, with his views upon the relations of Periodic fever and inflammation of the lungs.

The febrile poison, continues Senac, falls not only on the brain, but also upon the organs of respiration. It less frequently, however, attacks these latter parts, nor, indeed, is the reason of this sufficiently understood. When it does attack them, its mode of action is not always the same. It most frequently excites spasms in the respiratory organs, which are, at the same time, communicated to other parts of the system. From these spasms, or from the irritating and almost corrosive action of the poison, arise various pains. These sometimes attack the diaphragm, and affect the respiration in a most severe and dangerous manner. At other times the pains become fixed in the sides, and occasion such torture to the patients as to render them unable to change their positions. From these causes, respiration becomes confined and difficult, attended with cough, panting and shortness of breath. At times the disease assumes something of the form of a suffocative catarrh, or asthma, from congestion and oppression of the lungs, by means of thick mucus. But it occasionally appears in another shape, no less formidable, namely, that of a severe pleurisy or peripneumony. The patient is then affected with a spitting of blood, a fervid and lacerating pain in the thorax, and a depressed pulse. Senac still farther alludes to the conversion of intermittent fever into pleurisy and pneumonia in several chapters, and in his observations upon the method of detecting or distinguishing intermittents when disguised under the mask of other diseases, he relates a case of intermittent pleurisy cured by febrifuge remedies.

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*De Recondita Febrium Intermittentium, tum Remittentium Natura et de carum Curatione: variis experimentis et obsevationibus illustrata, 1796. Also Translation with notes by Charles Caldwell.—Philad, 1805.

George Cleghorn, in his "Observations on the Epidemical Diseases of Minorca, from the year 1744 to 1749," describes a fatal form of pneumonia and pleurisy, with distinct remissions. "When those pleurisies," says Cleghorn,

> "First became epidemical, their quick progress and uncommon mortality surprised me greatly. I attempted to cure them by bleeding, once or twice a day, if the complaints were violent, as I had always used to do in inflammatory fevers; but the remissions in the morning sometimes induced me to omit the operation; and the cessation of the symptoms, which generally happened about the third day, made me imagine that the danger was over; so that before the patients were blooded above two or three times, the exacerbation came on upon the fourth or fifth day, and defeated all attempts by bleeding, blistering, or otherwise to relieve them.
>
> "Those unforeseen events startled me greatly, and led me to review the whole progress of the disease, its symptoms and issue. I had observed that some escaped by means of expectoration and purulent urine, without much assistance from phlebotomy; and considering the periodical revolutions of the fever, the quick transition of the stitches from one part to another together with the prevailing color of the blood, as well as that of the spitting, and other excretions, I was apprehensive that those were what authors call bilious pleurisies, which they allege are exasperated by large evacuations:* particularly Duretus,† who exclaims with great vehemence against those physicians who trust principally to bleeding in the care of those diseases, without waiting for the natural evacuations." Loc cit. pp. 164–5.

Morton appears to have frequently detected the malignant intermittent concealed under the mask of pneumonia and pleurisy. This physician relates, among others, the case of a man who was seized in the morning with a violent shivering, and a pain in the thorax of so severe a character as to render respiration scarcely practicable. The pulse of the patient was small and rapid, his weakness was extreme, and universal coldness overspread all the limbs. Notwithstanding these symptoms, blood-letting from the arm was employed as the necessary and proper remedy for this spasmodic state of the respiration. When, however, from the nature and return of the paroxysms, Morton detected a fever of a malignant character, masked under the appearance of a peripneumony, he made the bark the principal foundation of his treatment, and succeeded in arresting the disease.

Lautter, as quoted by Alibert, in his treatise on malignant intermittents, has recorded two similar cases in his Hist. Medic. bienn. morb. rural, etc.; Casus v. and ix.

Case 707: A laborer of Luxembourg, thirty years of age, of a dry temperament, being engaged in threshing corn, was seized, first with a trembling, and then with a violent coldness, to which succeeded a short hot fit, and great thirst. The principal symptom was an excessive pain in the left side, which considerably impeded respiration. Being obliged to quit his work, he took to his bed; the fever continued nearly eighteen hours in the same state, and then underwent a perceptible remission. On the morning of the day following, the patient was still better. Although he was rather feeble, the stitch in his side continued, and he was certainly in some degree feverish, yet he went to work again, but all the symptoms returning toward evening, he again took to his bed. Lautter was called in; he found his patient laboring under a high fever, his pulse was hard, his respiration laborious, painful, and almost suppressed; the pain in the side was extremely acute; there was no cough. From the history of the disease, the physician discovered immediately that it was a malignant intermittent, masked by the predominant symptom of pleurisy; not being able to strike immediately at the root of the disease, because the exacerbation was then at its height, he employed himself in moderating the violence of the symptoms. He drew from the arm of the affected side ten ounces of blood, which was covered with an inflammatory crust, and ordered an emollient cataplasm to be applied to the part where the pain lay, and to be frequently renewed. Internally he administered barley-water with oxymel and nitre; the patient experienced relief, his respiration became easier, and the pain in his side abated; yet he passed a sleepless night with heat and great thirst. On the day following, his pulse was indeed less frequent, and was not hard, yet he had a high fever; the pain in the side continued, the urine, which was very high colored, deposited a lateritious sediment; the symptoms were now much milder, but as they had not altogether disappeared, the foregoing remedies were continued. In the evening, the disease resumed completely its first state and appearance. On the morning of the following day, there was no remarkable change, except that the acute pain in the right side disappeared for a short time, but soon returned again; the urine had undergone no change since the day before, the skin was constantly cold, etc. Lautter discovered immediately the malignant character of the fever. He took advantage of the remission to administer an ounce of the bark in the space of twenty-four hours; the next paroxysm was a very moderate one; and by continuing the use of the same remedy, the disease was radically cured.

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*Ballon. Epid. Sparsim. Bianch. Hist. Hep. p, iii. § viii. etc. Bagl. Prax. Med. 1, i. c. ix. Lancis Epid. Rom. c. vi.

†O homines republicæ calamitosos atque funestos! ipsam pleuritidem, quae sua sponte nullius operis indigens cum tali sputo quiesceret, ex eventur reddunt mortiferam. Duret in Praenot. Coac.

Case 708: A woman, sixty years of age, having her system greatly heated by exercise, exposed herself imprudently to the coolness of the evening. She was attaked by a cold fit, which was followed by a fever of great intensity. A severe pain occurred in the right side, extending round to the spine; a dry and frequent cough added to its acuteness; the respiration was short and laborious, and the succeeding night was passed without sleep. Lautter was called in; he found the pulse greatly agitated, full and hard, the tongue white and dry. Taking the disease for a pleurisy, he drew blood from the arm of the side affected, and laid an emollient cataplasm on the part where the pain was situated; the blood was covered with an inflammatory crust. The symptoms became milder.

On the same day, at one o'clock in the afternoon, the shivering returned with a slight degree of coldness; the febrile heat, the cough, the pain, etc., were all augmented; the pulse was as full and as hard as at first; blood was consequently drawn a second time, and exhibited again an inflammatory crust. There was now a remission of the febrile symptoms. On the evening of the day following, the cold fit returned; the pain, the heat, the cough, etc., increased considerably, in consequence of which the patient passed a very bad night.

Next day there was a remission; afternoon, another exacerbation, ushered in by a cold fit. The physician contented himself with repeating the application of cataplasms, and administering cooling drinks. He had no further recourse to blood-letting, because the patient's strength was greatly exhausted, and from the progress of the disease and the copious sediment of the urine, it was easy to discover a double tertian remittent lurking under the mask of pleurisy. Lautter gave an ounce of a mixture of bark [illegible] taken previously to the return of the paroxysm which was very near at hand. D[illegible]ucceeding night, the patient experienced only a great heat, but the cough and the pain in the side did not increase. On the following day, the same medicine was continued, and there was scarcely even the shadow of an exacerbation. By the continued use of the bark, the patient was very soon restored. (A treatise on Malignant Intermittents, by J. L. Alibert, translated by Charles Caldwell, M. D.; Phila., 1807: pp. 46, 50.) Alibert, in the same connection, recounts a similar case of intermittent pneumonia, occurring in a student of medicine in Paris, which was successfully treated by wine and bark.

Case 709: Laennec observed the existence of intermittent malarial pneumonia (pernicious pneumonic fever) in a muscular, robust man, who had entered the hospital with a recent syphilis. On the sixth day of his admission, the patient suffered with a paroxysm of intermittent fever of considerable violence, and he stated that he had had a paroxysm two days before. A third paroxysm occurred on the third day after, but it was entirely different from the preceding paroxysm; it commenced with a more considerable chill, was accompanied with a violent headache, extreme dyspnœa, and hemoptysis. Upon exploring the chest during the middle of the paroxysm, the respiratory murmur was found unaltered except at the root of the lungs, where it was masked by a *rale crepitant* well characterized, principally on the right side. Laennec, without hesitation, declared the disease a double pneumonia in its initial stage; tartar emetic, six grains; sulphate of quinine, eighteen grains, to be taken in three doses. The patient vomited a little and had but one stool; the next day he thought himself cured. But as the *rale crepitant* had not entirely disappeared with the cessation of the febrile paroxysm, the two prescriptions were continued. The following paroxysm was very short; the *rale crepitant* was slightly developed, and the hemoptysis reappeared; but the fever had scarcely ceased, when all the symptoms disappeared (that is to say, as soon as the disease ceased, it no longer existed.) The tartar emetic was discontinued on the fifth day, the respiration having become pure and natural; the sulphate of quinine was continued for some days. The patient was now cured of the fever, and the anti-syphilitic treatment, which had been suspended, was resumed. Three weeks after, the intermittent fever reappeared, it was now simple and benign, and a few doses of the sulphate of quinia entirely arrested it; the patient remained six weeks longer in the hospital, and left in good health. In like manner M. Fleury records a remarkable case of tertian pneumonia, which was attended with almost complete disappearance of the distressing pneumonic symptoms during the intermission of the fever, and which was arrested by quinine and bark. (See Physiological Pyretology; or a Treatise on Fevers, etc., by F. G. Boisseau, trans. by J. R. Knox, M. D.; Philadelphia, 1832; pp. 443–436.)

We might present the testimony of many other writers, as Ramazini, Lancisi, Sydenham, Huxham, Sauvages, and Broussais, to show that the notion of the production of pneumonia, by the same causes which generate the various forms of malarial fever, has been not only long, but widely held by the medical profession; but the authors already cited are believed to be sufficient for the establishment of this proposition.

Without attempting at this time to settle the question as to whom belongs the honor of first giving bark and quinine in pneumonia and inflammations generally, we have shown conclusively that the former remedy has been freely used in the treatment of all fevers and inflammations for at least a century; and as the principles which led to its administration did not differ materially from those which now lead to the use of quinine, and as the bark necessarily included this constituent, if any credit is due to this method of treating inflammations, it rests with the older writers.

We will endeavor in the next place to determine the relations of malarial fever to pneumonia, by the application of those facts and principles which have been developed by our own investigations.

We shall content ourselves with the expression of only those general results of our investigations which bear upon the treatment of pneumonia.

RELATIONS OF PNEUMONIA TO MALARIA.

We will in the first place, institute a comparison between the mortality occasioned by pneumonia in malarious and non-malarious locations. The collection of the following statistics, has necessarily involved much time and labor, in the inspection of the topography, and in the classification and consolidation of the mortuary records of various cities.

Upon examination of the mortuary records of various cities, it was found that the deaths from Pneumonia, were frequently entered under the heads of Pleurisy, Inflammation of the Lungs, and Congestion of the Lungs. I have grouped together the deaths from these causes, as well as those from Hydrothorax. Hydrothorax as a general rule results from Pleuritis, a disease referable to the same general causes as pneumonia, and often associated with it. This grouping was absolutely necessitated by the various modes of recording diseases adopted by different cities. Thus in Savannah, and in the southern portion of Georgia, Pneumonia was often called Pleurisy, and was evidently entered under this name upon the bills of mortality, or rather upon the mortuary records of the various cemeteries.

MORTUARY STATISTICS OF SAVANNAH, GEORGIA.

No more important field presented itself than Savannah, Georgia, for the investigation of the relations of Malaria to Pneumonia, and I consolidated from the mortuary records of this city various tables, presenting at one view the deaths caused annually and monthly, by fevers, and inflammations, and all other causes during a period of 50 years, 1804 to to 1854, inclusive.

These statistics related exclusively to the whites, as the record of diseases of the blacks were so imperfect, as not to permit of any general or specific classification. The relations of the mortality to the population, were calculated from the following data:

Population of Savannah, 1800; whites, 2618; blacks and colored, including negro slaves, 2548; total 5166: 1810, whites, 2490, blacks and colored, 2725; total, 5215: 1820, total population, 7523: 1830, total population, 7776: 1840, whites, 5778; blacks and colored, 5436; total, 11,214: 1850, whites, 8395; blacks and colored, 6917; total, 15,312: 1860, whites, 13,875; blacks and colored, 8417; total, 22,292: 1870, whites, 15,166; blacks and colored, 13,068; total, 28,235.

Savannah is situated on the Savannah River, eighteen miles from its mouth, on a sandy plain, elevated forty-two feet above half tide. On the north, this plain is terminated abruptly by the Savannah River, a turbid stream pursuing its sluggish course through the low grounds and rice fields of South Carolina and Georgia. On the east and west, the city is flanked by extensive tide swamps, formerly under wet (rice) culture at the present time, and for the past fifty years, or more, under dry culture. The dry culture system of the extensive paludal districts above and below Savannah, and of the islands and lands immediately across the river in front of the city, was instituted in 1818. The sandy plain extends for several miles beyond the city. Savannah therefore, is surrounded on all sides, except the south, by malarious districts. In fact, up to 1818, she might justly have been regarded, as a city situated in the midst of a vast marsh, or rice field, reclaimed by a system of dams and canals, from its original condition of a rich alluvial swamp.

With the establishment and perfection of the *dry-culture* system, and with the draining and cultivation of the surrounding low lands, the health of Savannah has steadily improved. Thus in the ten years, from 1810 to 1819 inclusive, during the wet (rice) culture system, the deaths amongst the whites, average as 1 in 14 of the average population of those years; in the ten years, from 1820 to 1829, inclusive, as 1 in 17; in the ten years from 1830 to 1839, inclusive, as 1 in 24; in the eight years, from 1840 to 1847, inclusive, as 1 in 33.

The heavy mortality occasioned by fevers, chiefly referable to the action of heat and malaria, in Savannah, is shown by the following tables, giving the total deaths from fevers and other diseases, and by all diseases; and the monthly deaths from fevers in Savannah, during a period of 50 years, 1804 to 1853, inclusive.

Total Annual and Monthly Deaths of the White Inhabitants of Savannah from Fever, and Total Deaths from other Diseases and from all causes, in Savannah, Georgia, during a period of 50 *years,* 1804–1854.

YEARS.	TOTAL DEATHS FROM FEVERS.	TOTAL DEATHS F'M OTHER DISEASES.	TOTAL DEATHS.		DEATHS FROM FEVERS IN											
					January...	February...	March......	April.......	May.........	June.........	July.........	August.....	September.	October....	November..	December..
1804...........	77	130	207	...	...	...	...	...	1	3	6	8	39	17	2	1
1805...........	112	126	238	...	...	1	...	...	...	1	3	14	21	57	13	2
1806...........	52	107	159	...	...	...	...	1	...	...	2	5	11	24	9	...
1807...........	80	150	230	...	...	1	1	...	...	...	1	11	27	29	10	...
1808...........	77	142	219	...	1	...	...	...	...	...	9	10	22	21	11	3
1809...........	63	120	183	...	1	...	...	1	...	1	5	12	20	12	9	2
1810...........	46	117	163	...	...	...	...	...	1	...	...	5	15	20	2	3
1811...........	87	125	212	...	...	1	...	3	1	2	9	24	31	10	4	2
1812...........	120	106	226	...	3	...	...	...	2	4	11	11	30	50	5	5
1813...........	64	150	214	...	4	3	...	1	...	1	...	12	13	21	4	5
1814...........	166	134	300	...	1	...	1	...	1	8	15	25	55	46	14	...
1815...........	130	103	233	...	1	...	...	2	1	4	10	17	58	27	12	...
1816...........	146	126	272	...	...	...	...	4	2	4	5	5	56	56	10	4
1817...........	313	148	461	...	4	5	2	...	2	8	45	37	46	104	47	13
1818..........	76	135	211	...	4	4	4	5	5	4	4	9	14	21	...	...
1819...........	323	187	510	...	...	...	1	3	...	4	24	28	66	147	40	9
1820...........	649	168	817	...	4	4	1	...	3	14	39	110	214	197	53	10
1821...........	183	202	385	...	...	3	1	1	1	4	13	18	36	62	27	17
1822...........	133	158	291	...	...	3	4	...	1	19	12	16	16	35	18	1
1823...........	109	159	268	...	1	...	3	2	2	8	16	21	24	20	9	3
1824...........	42	94	136	...	1	1	2	1	...	3	5	8	10	9	2	...
1825...........	23	103	126	...	...	2	2	. .	...	2	1	3	5	5	2	1
1826...........	62	173	235	...	2	1	2	1	1	1	8	7	8	13	15	3
1827...........	96	225	321	...	2	...	...	...	3	9	9	13	26	26	5	3
1828...........	23	123	146	...	1	1	1	...	1	1	4	3	6	3	1	1
1829...........	32	177	209	...	...	1	...	...	1	...	4	6	6	6	6	1
1830...........	28	139	159	...	1	1	1	...	1	1	3	4	8	6	2	...
1831...........	17	130	147	...	...	...	1	...	...	1	...	...	5	5	4	1
1832...........	57	159	216	...	...	...	...	1	...	...	8	25	3	13	6	1
1833...........	36	166	202	...	1	2	...	1	...	2	6	5	10	6	3	...
1834...........	34	163	197	...	1	...	1	2	1	1	1	2	9	10	5	1
1835..........	57	171	228	...	...	1	...	1	...	4	17	14	10	7	1	2
1836...........	38	211	249	...	...	1	...	1	...	1	13	6	3	9	1	3
1837...........	100	258	358	...	1	1	...	1	1	3	10	11	11	25	30	6
1838...........	108	163	331	...	...	1	...	...	3	2	3	11	32	41	14	1
1839...........	154	213	367	...	2	1	...	...	...	2	4	10	38	64	27	6
1840...........	124	256	380	...	4	3	1	2	3	9	7	19	23	19	29	5
1841...........	83	222	305	...	1	...	2	5	...	3	3	11	19	30	6	3
1842...........	62	210	272	...	1	1	...	...	3	1	7	13	15	11	10	...
1843...........	91	165	256	...	1	...	...	...	...	...	2	3	28	33	22	2
1844...........	51	196	247	...	...	...	...	...	1	5	15	10	10	6	1	2
1845...........	57	172	229	...	1	...	...	...	...	3	7	6	13	20	6	1
1846...........	60	180	240	...	...	1	...	...	...	4	6	14	9	15	8	3
1847...........	28	182	210	...	1	...	...	...	2	...	3	1	11	7	2	1
1848..........	50	248	295	...	...	...	...	3	...	3	5	8	4	18	9	...
1849...........	71	286	357	...	...	1	1	...	5	1	3	10	13	25	10	2
1850...........	63	321	384	...	1	...	...	1	...	...	2	4	20	26	8	1
1851...........	75	339	414	...	...	2	1	...	2	2	5	3	23	29	5	3
1852...........	202	440	642	...	...	...	1	...	...	9	7	38	41	61	42	3
1853...........	76	394	470	...	...	2	2	...	4	8	9	9	21	9	9	3
Total.........	4888	9444	14,332	...	46	49	36	43	59	171	416	585	1253	1532	559	139

Total monthly Deaths from all causes, Fevers excluded, and from all causes, including Fevers, in Savannah, Ga. during a period of Fifty years, 1804-1853, inclusive.—White.

YEAR.	Deaths from all Causes, Fevers excluded, each Month during Fifty years.—Whites TOTAL DEATHS FROM OTHER DISEASES.												Deaths fm. all Causes, Fevers included, each Month during 50 years.—Whites TOTAL DEATHS FROM FEVERS AND [illegible]											
	January…	February…	March…	April…	May…	June…	July…	August…	September	October…	November	December…	January…	February…	March…	April…	May…	June…	July…	August…	September…	October…	November…	December…
1804	10	11	8	8	6	11	14	12	10	12	17	11	10	11	8	8	7	14	20	20	49	29	[illegible]	[illegible]
1805	13	10	9	6	11	10	5	8	18	15	11	10	13	11	9	6	11	11	8	22	39	72	[illegible]	[illegible]
1806	9	9	6	10	2	5	7	10	12	19	10	8	9	9	6	11	2	5	9	15	23	43	[illegible]	[illegible]
1807	9	16	12	9	9	12	16	9	10	21	20	7	9	17	13	9	9	12	17	20	37	50	36	7
1808	16	10	10	9	12	11	5	8	12	16	24	9	17	10	10	9	12	11	14	18	34	37	35	12
1809	5	7	6	11	9	6	10	9	11	19	12	15	6	7	6	12	9	7	15	21	31	31	21	17
1810	10	12	14	6	5	8	11	7	5	16	10	13	10	12	14	6	6	8	11	12	20	36	12	16
1811	10	10	15	7	5	12	9	5	14	12	18	8	10	11	15	10	6	14	18	29	45	22	[illegible]	[illegible]
1812	12	6	9	11	4	8	4	6	14	16	17	8	15	6	9	11	6	12	15	17	44	56	[illegible]	[illegible]
1813	8	12	6	15	8	12	7	20	17	19	15	11	12	15	6	16	8	13	7	33	30	40	19	16
1814	16	13	8	9	15	10	5	15	12	12	10	9	17	13	9	9	16	18	20	40	67	50	[illegible]	9
1815	8	10	6	6	13	8	3	6	9	10	12	10	9	10	6	8	14	12	13	23	67	37	24	10
1816	19	9	14	11	9	8	5	14	14	6	11	6	19	9	14	16	11	12	10	19	70	62	21	10
1817	14	16	8	12	12	8	7	9	12	23	12	15	18	21	10	12	14	16	52	46	58	127	[illegible]	[illegible]
1818	17	16	13	11	8	4	14	8	15	17	…	14	21	20	17	16	13	8	18	17	29	38	—	14
1819	9	11	16	8	10	18	10	13	26	28	22	17	9	11	17	11	10	22	34	41	92	175	[illegible]	[illegible]
1820	14	7	7	11	13	15	14	7	18	31	13	18	18	11	8	11	16	29	53	117	232	228	[illegible]	[illegible]
1821	18	24	16	22	32	11	8	17	16	17	16	5	18	27	17	23	33	15	21	35	52	79	43	[illegible]
1822	13	16	10	12	10	11	9	15	14	24	15	17	13	19	14	12	11	30	21	31	30	59	33	19
1823	15	13	19	10	11	16	8	7	13	13	20	14	16	13	22	12	13	24	24	28	37	33	29	17
1824	8	7	9	5	4	4	5	10	11	11	9	11	9	8	11	6	4	7	10	18	21	20	11	11
1825	8	6	10	5	3	4	12	8	11	13	11	8	8	8	12	5	3	6	13	11	20	18	13	9
1826	8	13	10	12	7	15	13	13	15	16	25	16	10	14	12	13	8	16	21	20	23	39	40	[illegible]
1827	22	15	15	12	14	20	19	11	26	21	28	12	24	15	15	12	17	29	28	34	52	47	33	[illegible]
1828	7	4	16	6	7	14	17	11	9	12	13	8	8	5	17	6	8	15	21	14	14	15	[illegible]	9
1829	8	12	10	19	15	28	12	13	11	17	23	10	8	13	10	19	16	28	16	19	17	23	[illegible]	[illegible]
1830	10	9	12	8	6	16	11	8	13	17	6	15	11	10	13	8	7	17	14	12	21	23	6	18
1831	8	7	13	5	7	8	18	8	10	20	10	16	8	7	14	5	7	9	18	8	15	25	14	16
1832	18	13	12	11	8	8	14	13	18	13	15	16	18	13	12	12	8	8	22	38	21	26	21	17
1833	6	6	6	11	13	11	10	21	20	24	28	10	7	8	6	12	13	13	16	26	30	30	31	10
1834	13	8	11	9	12	11	9	12	25	25	18	10	14	8	12	11	13	12	10	14	34	35	23	11
1835	15	20	12	7	12	14	15	18	17	13	8	20	15	21	12	8	12	18	32	32	27	[illegible]	9	22
1836	20	19	25	12	15	18	12	15	14	15	18	28	20	20	25	13	15	19	25	21	17	24	19	[illegible]
1837	20	21	16	13	18	29	30	23	17	17	31	23	21	22	16	14	19	32	40	34	[illegible]	42	[illegible]	[illegible]
1838	17	16	14	15	17	20	22	19	16	28	25	14	17	17	14	15	20	22	25	30	48	69	39	[illegible]
1839	12	19	16	15	17	9	10	13	26	37	15	24	14	20	16	15	17	11	14	23	64	101	42	[illegible]
1840	21	16	23	14	21	19	11	21	22	36	35	17	25	19	24	16	24	28	18	40	45	55	64	[illegible]
1841	24	19	19	18	18	21	11	22	24	21	15	9	25	19	21	23	18	25	14	33	43	51	21	12
1842	24	25	20	16	16	9	5	18	15	22	22	17	25	26	20	16	19	10	13	31	30	33	32	[illegible]
1843	12	17	17	8	8	5	14	14	17	24	19	10	13	17	17	8	8	5	16	17	45	57	41	11
1844	12	12	18	9	11	13	17	17	27	26	16	19	12	12	18	9	12	18	32	27	37	32	17	[illegible]
1845	16	17	13	10	16	11	5	10	15	26	14	19	17	17	13	10	16	14	12	16	28	46	[illegible]	[illegible]
1846	7	13	13	14	15	8	19	19	17	23	11	21	7	14	13	14	15	12	25	33	26	38	19	[illegible]
1847	22	12	19	16	10	15	7	18	16	16	12	19	23	12	19	16	12	15	10	19	27	23	14	[illegible]
1848	14	19	18	19	26	15	11	23	22	33	28	24	14	19	18	22	26	18	16	31	26	51	37	[illegible]
1849	29	13	20	18	26	15	28	17	37	51	30	26	29	14	21	18	31	16	31	27	50	76	[illegible]	[illegible]
1850	23	27	29	17	17	22	23	16	35	29	39	34	24	27	29	18	17	22	25	30	55	55	47	[illegible]
1851	30	26	20	31	26	29	20	21	26	27	43	40	30	28	21	31	28	31	25	24	49	56	[illegible]	[illegible]
1852	32	34	25	22	24	26	30	31	60	58	59	39	32	35	26	22	24	35	37	69	161	119	101	[illegible]
1853	44	45	21	22	18	21	22	38	45	42	37	39	44	47	23	22	22	29	31	47	66	51	[illegible]	[illegible]
Totals	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…

It is evident, from the preceding tables, that the various forms of fever, including Yellow fever, Remittent, Intermittent and Congestive paroxysmal fevers, occasioned more than one-third of the mortality in Savannah, Georgia, during a period of fifty years, 1804–1853, inclusive: or, more exactly, four thousand eight hundred and eighty-eight deaths from the various forms of fever, in a grand total of fourteen thousand three hundred and thirty-two deaths from all causes; or one death from the various forms of the so-called malarial fevers in 2.9 deaths from all causes. The heaviest mortality from fevers occurred in the months of July, August, September, October and November; and, in two months, viz: September and October, two thousand seven hundred and eighty-five deaths were caused by fevers alone, during fifty years, out of a grand total of four thousand eight hundred and eighty-eight deaths; more than one-half the deaths from the various forms of fever, therefore occurred in the autumn, during only two months. During the entire period of fifty years, only eighty-three deaths were recorded as due to the various forms of continued fever, entered in the mortuary record, as typhoid, typhus, nervous, spotted and continued fevers.

If, on the other hand, the fevers be excluded from the consolidated mortuary record, we observe a remarkable uniformity in the monthly deaths.

The great increase in the death-rate during the months of July, August, September, October and November, was, therefore, clearly referable to the action of the causes, as heat, moisture and malarial exhalations, inducing the various forms of fevers, and, especially, paroxysmal fevers.

A careful examination of the mortuary records of the colored population, revealed the facts that whilst they were by no means exempt from the so-called malarial or paludal fevers, they suffered to a far less extent than the whites, and their bill of mortality presented a more uniform character throughout the entire year. This statement will be sustained by the following consolidated record of the monthly deaths amongst the colored inhabitants of Savannah, Georgia, during a period of twelve years—1840–1851, inclusive:

Monthly Deaths amongst Blacks and Colored (Negro), Inhabitants of Savannah, Ga., during a period of Twelve years, 1840–1851, *inclusive.*

YEAR.	1840	1841	1842	1843	1844	1845	1846	1847	1848	1849	1850	1851
January	16	12	21	17	10	15	7	11	19	34	28	20
February	7	18	15	7	8	19	6	11	20	21	19	8
March	11	12	24	16	11	24	10	13	15	24	24	13
April	18	8	18	10	12	11	13	12	15	16	31	17
May	21	12	24	15	13	26	19	10	23	28	23	18
June	19	11	15	18	19	11	17	11	20	25	25	29
July	13	18	15	29	19	12	11	17	25	21	16	18
August	20	20	14	15	20	8	18	13	13	32	15	16
September	20	13	19	11	23	18	14	17	21	25	21	16
October	26	19	18	23	16	15	18.	19	31	19	28	23
November	18	22	13	13	17	19	20	21	18	29	29	13
December	16	18	11	6	15	21	15	20	19	15	22	12

An examinaton of the "Colored" mortuary record revealed the fact that whilst the monthly mortality was more uniform, at the same time, the deaths from pneumonia, pleuritis and tetanus were relatively greater than amongst the white inhabitants of Savannah.

Deaths Caused by Pneumonia, Pleurisy and Hydrothorax, and by all Diseases and Accid White Population of Savannah, Georgia, during a Period of Fifty Years, 1804–1853, *i with the ratio of deaths from Pneumonia, Pleurisy and Hydrothorax, to the total death f causes, and to the White Population, and the ratio of deaths from all causes to the popul*

Year.	Deaths from Pneumonia, Pleurisy and Hydrothorax.	Total deaths from all causes.	Ratio of deaths from Pneumonia, Pleurisy and Hydrothorax, in total deaths from all causes. 1 death in total deaths.	Ratio of deaths from Pneumonia, Pleurisy and Hydrothorax, in White Population. 1 death in total White Population.	Ratio of Deaths from all causes, in total White Population. 1 death in total White Population.	Year.	Deaths from Pneumonia, Pleurisy and Hydrothorax.	Total deaths from all causes.	Ratio of deaths from Pneumonia, Pleurisy and Hydrothorax, in total deaths from all causes. 1 death in total deaths.	Ratio of deaths from Pneumonia, Pleurisy and Hydrothorax, in White Population. 1 death in total White Population.
1804......	9	207	23.	290	12.6	1829......	7	209	29.8	657
1805......	13	238	18.3	201	11.0	1830......	6	159	26.5	783
1806......	7	159	22.8	375	16.5	1831......	6	147	24.5	800
1807......	6	230	38.3	436	11.2	1832......	12	216	18.0	408
1808......	5	219	43.8	523	11.9	1833......	6	202	33.6	833
1809......	6	183	30.5	436	14.3	1834......	4	197	49.2	1,275
1810......	10	163	16.3	249	15.2	1835......	4	228	57.0	1,300
1811......	3	212	70.6	1,003	14.2	1836......	9	249	27.6	588
1812......	8	226	28.5	376	13.3	1837......	9	358	39.7	599
1813......	8	214	27.0	376	14.0	1838......	5	331	66.2	1,100
1814......	11	300	27 2	282	10.3	1839......	3	367	123.3	1,866
1815......	5	233	46.6	640	13.7	1840......	5	380	76.0	1,177
1816......	3	272	90.6	1,100	12.1	1841......	5	305	51.0	1,200
1817......	4	461	115.2	850	7.6	1842......	9	272	30.2	699
1818......	10	211	21.1	350	16.5	1843......	12	256	21.3	533
1819......	3	510	170.0	1,200	7.0	1844......	11	247	22.4	600
1820......	3	817	272.2	1,233	4.5	1845......	7	229	32.7	971
1821......	7	385	55.0	542	9.8	1846......	7	240	34.2	1,000
1822......	8	291	36.3	487	13.4	1847......	8	210	26.2	887
1823......	6	268	44.6	666	14.9	1848......	13	298	22.9	567
1824......	3	136	45.3	1,033	30.1	1849......	10	357	35.7	800
1825......	7	126	18.0	600	32.5	1850......	12	384	32.0	699
1826......	8	235	29.3	525	18.3	1851......	13	414	31.8	684
1827......	15	321	21.4	293	13.7	1852......	24	642	26.6	391
1828......	3	146	48.6	1,500	30.8	1853......	18	470	26.1	349

Total deaths from Pneumonia, Pleurisy and Hydrothorax, 497.
Total deaths from all causes, 14,332.
Ratio of deaths from Pneumonia, Pleurisy and Hydrothorax in total deaths from all causes, one death in 28

Of four hundred and ninety-seven deaths caused by Pneumonia, Pleurisy and thorax, amongst the white inhabitants of Savannah, Georgia, during a period years, 1804–1853, inclusive, sixty-five occurred in January; sixty-seven in Fe fifty-six in March; twenty-five in April; twenty-seven in May; nine in June; in July; twelve in August, nineteen in September; nineteen in October; thi in November, and forty-six in December.

Thus, during the season of Spring (March, April and May), one hundred a deaths were caused by Pneumonia, Pleurisy and Hydrothorax, during a period years; during Summer (June, July and August), thirty-four deaths; during (December, January and February), one hundred and seventy-eight deaths.

It is evident, therefore, that Pneumonia, Pleurisy and Hydrothorax were i nah, Georgia, during a period embracing half a century, related to cold a tudes of temperature, rather than to the action of Malaria, which caused th number of deaths, at the period in which the smallest number from Pneum risy and Hydrothrax occurred.

Out of a grand total of fourteen thousand three hundred and thirty-two de all causes, during a period of fifty years in Savannah, only four hundred and ninety-seven deaths are due to Pneumonia, Pleurisy and Hydrothorax, or one death in 28.8 from all causes.

With reference to the relation of the deaths from these diseases to the population, the highest rate occurred in 1805, viz: one death in two hundred and one inhabitants, and the lowest rate occurred in 1828, viz: one death in fifteen hundred inhabitants.

The ratio of deaths from these diseases, to the population, was greater during several years of the Wet Culture System, but the difference was very slight, and in the majority of the years of this period, it was less than under the Dry Culture.

MORTUARY STATISTICS OF AUGUSTA, GEORGIA.

Augusta is situated on the southwest bank of the Savannah river, one hundred and twenty miles N. N. W. of Savannah, and one hundred and thirty-six N.W. of Charleston, in latitude 33°, 33′, longitude 5°, 18′. The city is generally well built, and is handsomely laid out, with wide streets crossing each other at right angles. The beautiful alluvial plain upon which the city is located, is elevated about one hundred and fifty feet above the sea, and abont thirty-two feet above low-water mark in the Savannah river. Opposite Centre street, the river is three hundred and fifty yards wide, and below Mill street, it is one hundred and ninety-one yards wide. On the 28th of May, 1840, the river rose thirty-seven feet above the low-water mark, and inundated a large portion of the City and occasioned much injury to property. In March, 1841, the river rose thirty-three feet. The soil of the plain upon which Augusta stands, unlike the sandy, porous soil of Savannah, consists of a rich deposit or silt from the river, which is composed chiefly of a light brownish-yellow clay. The falls in the Savannah river, about eight miles above the city, are situated on the line of the junction of the granitic and tertiary regions.

Population of Augusta, 1840, whites and blacks, 6403; 1845, whites, 3948; free persons of color, 440; slaves, 3114; total, 7502. 1850, whites, 5256; blacks and colored, 4,961; total, 10,217. 1860, whites, 8444; blacks and colored, 4049; total, 12,493. 1870, whites, 8957; blacks and colored, 6431; total, 15,389.

Deaths from Pneumonia and Pleurisy each month; Total yearly deaths from these diseases, and from all causes; and ratio of deaths amongst Whites and Blacks, from Pneumonia and all causes, in population, Black and White, in Augusta, Georgia, during a period of Twenty-one Years, 1845–1865, inclusive, consolidated by Joseph Jones, M. D.

Year.	Whites.															Blacks and Colored.															Total deaths from Pneumonia and Pleurisy, Blacks and Whites.	Total deaths from all causes, Blacks and Whites.	Proportion of deaths from Pneumonia and Pleurisy, amongst Blacks and Whites, in deaths from all causes. 1 death in	Proportion of deaths from Pneumonia and Pleurisy, in Whites, to White population. 1 death in	Proportion of deaths from Pneumonia and Pleurisy, amongst Blacks, in Black population. 1 death in	Proportion of deaths from Pneumonia and Pleurisy in Blacks and Whites, to total population. 1 death in	Proportion of deaths, all causes, in White population. 1 death in	Proportion of deaths, all causes in Black and Colored population. 1 death in	Proportion of deaths, all causes, in total population, Whites and Blacks. 1 death in
	January	February	March	April	May	June	July	August	September	October	November	December	Total deaths from Pneumonia and Pleurisy.	Total deaths from all causes.	Proportion of deaths from Pneumonia and Pleurisy in deaths from all causes.	January	February	March	April	May	June	July	August	September	October	November	December	Total deaths from Pneumonia and Pleurisy.	Total deaths from all causes	Proportion of deaths from Pneumonia and Pleurisy in deaths from all causes.									
1845	2	2	3	3	...	...	1	...	...	...	...	...	11	72	6.5	...	...	...	...	...	...	...	...	...	1	...	...	1	67	67.0	12	139	11.5	391	4198	709	60	60	61
1846	...	...	4	...	...	...	...	...	...	...	...	...	4	89	22.2	...	...	1	...	...	...	...	...	...	...	...	...	1	96	96.	5	185	37.0	1124	4399	1983	50	44	48
1847	2	1	1	1	...	1	1	...	...	1	...	...	8	76	9.5	2	1	5	1	3	...	1	...	...	...	1	1	15	92	6.1	23	168	7.3	577	306	405	59	49	55
1848	1	2	1	2	...	...	...	...	...	...	...	3	9	113	12.6	1	1	2	2	...	1	...	...	...	1	...	2	10	123	12.3	19	236	12.4	547	480	511	43	39	41
1849	6	1	4	4	...	1	1	...	...	...	...	1	18	129	8.2	...	1	2	3	3	1	...	1	1	...	1	3	16	114	7.1	34	243	6.1	284	310	285	39	43	41
1850	1	1	4	1	2	...	...	...	1	1	1	2	14	178	12.5	1	1	2	3	3	3	2	...	...	...	1	...	16	150	9.3	30	328	10.9	375	310	340	29	33	31
1851	3	2	1	2	1	1	1	...	1	1	2	3	18	219	12.1	2	1	1	1	...	3	1	1	...	2	1	2	15	144	9.6	33	363	11.0	309	330	343	25	34	31
1852	4	3	5	1	3	1	2	...	1	...	2	...	22	255	11.5	1	3	2	1	...	...	1	1	...	...	3	2	14	155	11.0	36	410	11.3	266	354	319	23	32	28
1853	1	2	1	2	3	...	...	...	...	...	...	...	9	224	24.8	3	4	3	2	2	2	1	...	3	2	...	1	23	145	6.5	32	369	11.5	683	215	365	27	34	31
1854	1	5	2	2	3	1	...	...	...	...	...	5	19	384	20.2	1	...	2	2	1	2	...	...	...	...	2	...	10	154	15.4	29	538	18.5	338	496	406	17	32	22
1855	...	9	3	2	2	...	...	...	...	1	1	...	18	234	13.5	1	2	4	...	2	1	1	...	...	...	1	1	13	130	10.0	31	364	11.7	384	381	384	28	38	32
1856	2	2	2	2	1	...	...	2	2	...	...	2	15	236	15.7	4	3	1	1	2	...	...	1	1	2	2	...	17	131	7.7	32	367	11.4	462	291	382	29	37	32
1857	2	3	4	7	7	3	...	...	4	3	5	1	39	273	7.2	6	3	...	4	4	...	...	2	1	1	2	2	25	148	5.3	64	421	6.5	159	198	189	26	33	29
1858	3	1	5	2	1	1	...	1	...	1	1	1	17	223	13.1	1	1	3	2	1	1	3	2	...	1	2	2	19	110	5.7	36	333	9.2	442	261	343	27	45	36
1859	1	3	...	2	1	2	...	...	...	2	...	2	13	221	17.0	5	3	...	...	3	3	...	...	2	...	2	...	18	128	7.1	31	349	11.1	600	275	396	34	39	35
1860	4	1	7	4	...	...	1	1	3	4	1	2	28	282	10.0	1	2	2	2	1	...	...	2	...	2	1	1	15	113	7.5	43	395	9.1	301	269	290	30	35	31
1861	3	3	1	3	...	...	2	2	3	3	1	5	26	297	11.4	...	1	3	1	1	...	...	1	...	1	...	1	9	135	15.0	35	432	12.3	326	474	293	28	31	29
1862	7	6	2	9	7	...	1	1	...	1	2	3	39	449	11.5	5	1	6	6	3	2	...	...	...	3	...	3	29	189	6.5	68	638	9.3	210	156	180	19	23	20
1863	6	7	...	5	3	2	...	1	1	3	1	7	46	406	11.2	3	1	2	6	4	7	4	1	...	10	6	9	53	281	5.3	89	687	7.7	238	89	150	21	17	19
1864	4	17	4	4	2	5	2	1	1	3	3	2	48	589	12.2	15	10	4	6	9	...	5	7	...	5	2	1	64	238	3.7	112	827	7.3	180	78	120	14	21	16
1865	3	6	2	2	3	...	3	...	...	1	1	3	24	1291	53.7	13	4	7	5	4	4	5	5	3	7	8	10	75	789	10.5	99	2080	21.0	302	69	137	6	6	6
Total	56	79	56	60	39	18	14	9	13	25	21	42	435	6240	14.3	65	43	52	48	46	30	24	24	11	38	35	41	457	3324	7.2	893	9564	10.7						

In the preceding table I have endeavored to unfold the relations of Pneumonia and Pleurisy, to the seasons, to the white and black races, to other diseases, and to the general death rates of the white and negro races.

From this table it is evident, that in Augusta, Georgia, during a period of 21 years, 1845 to 1865, inclusive, 6240 deaths from all causes occurred amongst the whites; 435 of which were caused by Pneumonia and Pleuritis; the number recorded as due to the latter disease, being very small. Amongst the whites one death from Pneumonia was caused in 14.3 deaths from all causes. The highest relative mortality was caused amongst the whites in 1845, when one death from pneumonia occurred in 6.5 deaths from all causes, but the highest absolute mortality as related to the white population, occurred in 1864, when one in 180 of the white population died from Pneumonia and Pleurisy. The least relative mortality amongst the whites was in 1865, viz: 1 death in 53.7 deaths, but the least absolute mortality occurred in 1846, when only one in 1124 of the inhabitants died from Pneumonia and Pleurisy.

During the same period amongst the blacks and colored (negroes and mulattoes) out of a grand total of 3324 deaths from all causes, Pneumonia occasioned 457, or one death in 7.2. This disease therefore was relatively to the whole number of deaths, nearly twice as fatal amongst the negro race: this statement also is to a certain extent true of the absolute mortality occasioned in the negro race by Pneumonia and Pleurisy. The highest relative mortality amongst the negroes, occurred in 1864, and amounted to one death from Pneumonia and Pleurisy, in 3.7 deaths from all causes, and the lowest relative mortality in 1845 and 1846, in the former year being 1 in 67, and the latter 1 in 96; the highest absolute mortality occurred in 1864, when one in 69 of the negroes died from Pneumonia and Pleurisy.

During the period embraced in the table, the grand total of deaths in Augusta, Georgia, was 9564, and of this number Pneumonia caused 893, or one death in 10.7 from all causes in the white and black races.

Both in the white race and in the negro race, the disease was most fatal in the months of lowest temperature, and of greatest vicissitudes of weather; and it was least fatal in the hottest months, and those characterized by the heaviest mortality, from malarial paroxysmal diseases.

Both in the white and black races, the smallest mortality was occasioned in the months of June, July, August and September, only 141 deaths occurring in these three months, out of a total of 893 deaths. The heaviest mortality occurred in the months of December, January, February, March, April and May, 627 deaths being caused in these six months during a period of 21 years, and only 266 during June, July, August, September, October and November, the months of the highest temperature, and of the greatest malarial influence.

In Savannah, Georgia, on the other hand, out of a grand total of 14,332 deaths from all causes, amongst the white inhabitants, during a period of 50 years, only 497 deaths were due to Pneumonia, Pleurisy and Hydrothorax, or one death in 28.8.

A careful comparison of the mortuary statistics of Savannah and Augusta, which we have consolidated, classified, calculated and presented in the preceding tables will show that Pleurisy and Pneumonia caused both relatively and absolutely about twice as great mortality in Augusta. The statistics farther show that this difference is due not to any so-called malarial or paludal poison or cause, but rather to the greater severity, and more frequent changes of the climate of Augusta.

The preceding investigations clearly and unequivocally establish the absolute independence, in its origin or cause, of Pneumonia, from the cause or causes which produce the various forms of Paroxysmal Malarial Fevers.

This conclusion will be still farther sustained by a comparison of the following mortuary statistics.

Deaths from Pneumonia, Pleurisy and Hydrothorax in Charleston, South Carolina, in Whites and Blacks, also Total Deaths from all Causes and Proportion of Deaths to Population, during a period of 14 *years,* 1846, 1847, 1848, 1849, 1851, 1852, 1854, 1855, 1857, 1858, 1859, 1860, 1861, 1865. *Population of Charleston,* 1840, 29,261; 1850, *Whites,* 20,012; *Blacks and Colored,* 22,973; *total,* 42,985; 1861, *Whites,* 26,969, *Blacks and Colored,* 21,440, *total,* 48,209; 1870, *Whites,* 22,749, *Blacks and Colored,* 26,163, *total,* 48,956.

YEAR.	WHITES.															BLACKS AND COLORED.																					
	January,	February	March	April	May	June	July	August	September	October	November	December	Total Deaths, Pneumonia, Pleurisy and Hydrothorax	Total Deaths from all causes.	Proportion of Deaths from Pneumonia, Pleurisy and Hydrothorax in Deaths from all causes	January,	February	March	April	May	June	July	August	September	October	November	December	Total Deaths, Pneumonia, Pleurisy and Hydrothorax	Total Deaths, all causes	Proportion of Deaths from Pneumonia and Pleuritis, in Total Deaths all causes.	Proportion of Deaths from Pneumonia, Pleurisy and Hydrothorax. Whites and Blacks, in Deaths f'm all causes. 1 Death in	Proportion of Deaths from Pneumonia, Pleurisy and Hydrothorax amongst Whites, to population of Whites. 1 Death in	Proportion of Deaths from Pneumonia, Pleurisy and Hydrothorax amongst Blacks, to population of Blacks. 1 Death in	Total Deaths from Pneumonia, Pleurisy and Hydrothorax. Whites and Blacks	Proportion of Deaths from Pneumonia, Pleurisy and Hydrothorax, in Whites and Blacks, in Total population. 1 Death in	Total Deaths, all causes. Blacks and Whites	Proportion of Deaths from all causes in population. Bl'ks and Whites. 1 Death in
1846	2	...	...	3	...	...	...	...	...	2	...	...	7	258	36.8	2	2	2	...	1	2	2	...	2	2	...	...	16	349	21.8	26.3	1857	875	23	1606	607	47.71
1847	...	...	...	...	...	...	3	...	...	...	1	...	4	218	50.4	1	3	1	2	2	1	1	2	...	1	1	2	17	330	19.4	56.0	3500	823	21	1809	548	50.74
1848	2	1	4	2	...	...	3	1	1	3	1	1	19	307	16.1	3	2	...	3	...	...	...	...	2	...	2	1	13	310	23.8	19.2	767	1115	32	1218	617	43.11
1849	...	...	3	1	1	2	...	1	...	2	2	2	14	429	30.6	2	1	3	2	2	1	6	1	2	...	1	...	22	369	16.7	22.1	1037	704	36	1111	798	36.34
1851	1	3	1	1	...	1	1	...	...	2	2	1	13	389	29.9	8	6	4	1	3	5	3	2	3	2	2	3	42	533	12.7	16.7	1539	547	55	781	922	44.46
1852	1	6	3	2	4	1	1	...	2	...	2	2	24	861	35.8	7	5	6	6	1	5	2	4	1	3	5	5	50	721	14.4	21.3	833	458	74	580	1582	27.81
1854	2	...	1	1	1	...	1	3	...	1	1	2	13	1120	86.1	2	2	4	4	3	7	2	2	2	1	5	3	37	756	20.4	37.7	1576	635	50	880	1876	23.4
1855	2	3	2	8	...	...	...	...	...	1	2	3	21	402	19 1	7	5	2	5	3	1	...	2	1	3	2	1	32	686	21.3	20.9	1085	709	52	855	1088	45.90
1857	3	2	3	5	1	3	2	...	2	1	1	2	25	496	19.4	3	5	1	2	2	6	1	1	2	4	3	3	33	741	22.7	21.3	912	687	58	767	1237	42.37
1858	2	3	3	2	2	1	...	1	2	1	...	2	19	1252	65.8	4	4	...	1	5	6	2	...	5	4	2	3	36	670	18.6	34.9	1315	555	55	818	1922	26.14
1859	1	1	4	2	2	1	...	...	...	...	...	...	11	413	37.5	10	9	4	4	3	1	2	...	...	3	2	5	44	620	14.0	18.7	2363	477	55	854	1033	48.40
1860	2	6	3	2	2	3	2	...	1	1	...	...	22	719	32.6	5	12	9	7	2	2	1	...	1	2	3	...	44	753	17.1	22.3	1225	487	66	733	1472	37.38
1861	2	2	3	2	...	...	5	1	1	...	1	...	17	656	38.5	5	6	3	3	1	...	3	1	1	2	2	3	30	674	22.4	29.4	1586	714	47	1029	1380	36.09
1865	1	1	...	1	2	1	2	...	...	2	2	...	12	560	46.6	4	3	...	7	6	6	9	1	1	4	4	6	51	1508	29.4	32.8	1894	513	63	789	2068	9.70
Total	21	28	30	32	15	13	20	7	9	16	15	15	211	8080	38.2	63	66	39	47	34	43	34	16	23	31	34	35	477	9020	18.9	24.9	......	......	688	......	17,150	......

Deaths from Pneumonia, Pleurisy and Hydrothorax, and Total Deaths from all Causes amongst Whites, Blacks and Colored, in New Orleans, La., 1849 *and* 1850. *Population of New Orleans, U. S. C., Whites,* 89,459; *Blacks and Colored,* 26,916; *total,* 116,375.

YEAR.	WHITES.															BLACKS AND COLORED.																					
1849	13	8	15	9	5	4	2	3	2	7	7	6	80	7970	99.6	4	4	8	15	8	2	3	4	1	4	9	1	63	1876	29.7	68.8	1116	427	143	820	9846	11.8
1850	11	7	18	4	10	6	8	8	7	7	11	9	106	6336	59.7	4	5	5	8	7	2	2	2	1	...	2	...	38	1500	39.4	54.4	828	707	144	808	7836	14.9
Total	24	15	33	13	15	10	10	11	9	14	18	14	186	14306	77.2	8	9	13	23	15	4	5	6	2	4	11	1	101	3376	33.3	61.6	......	......	287	......	17,682	......

In New Orleans, in 1849, one death occurred in 11.2 of the White Population, and 14.4 of the Black Inhabitants.
In New Orleans, in 1850, one death occurred in 14.1 of the White Population, and 1.70 of the Black Inhabitants.

Deaths from Pneumonia, Pleuritis and Hydrothorax, and from all Causes, in New Orleans, La., during a period of 9 *years, embracing* 1849, 1850, 1853, 1867, 1869, 1870, 1871, 1872, 1873.

Population of New Orleans, U. S. C., 1850, *Whites,* 89,459; *Blacks and Colored* 26,916; *total,* 116,375
“ “ 1860, “ 144,596; “ “ 27,074; “ 168,670
“ “ 1870, “ 140,923; “ “ 50,456; “ 191,418

YEAR.	January........	February.......	March	April............	May.............	June	July.............	August	September	October	November	December.......	Total Deaths, Pneumonia, Pleurisy and Hydrothorax.	Propor'n of Deaths from Pneumo'a, Pleu'sy & Hydro'rax, in d'ths, all cau's.	Total Deaths from all Causes, Whites and Blacks.	Deaths from Pneumonia, Pleurisy and Hydrothorax, in Total Population.	Proportion of Deaths f'm all Causes, Whites and Blacks in Total Population.
1849............	17	12	23	24	13	6	5	7	3	11	16	6	143	68.8	9862	813	11.8
1850............	15	12	23	12	17	8	10	10	8	7	11	9	144	61.6	7836	808	14.9
1853............	25	26	31	32	16	12	5	10	8	10	5	13	194	80.5	15,633	794	9.8
1867............	47	31	36	24	14	19	10	7	30	31	21	29	299	33.4	10,096	618	16.8
1869............	17	35	43	60	56	19	19	6	15	17	20	44	351	17.0	6001	569	31.6
1870............	49	31	39	32	26	20	18	16	34	20	16	30	331	22.3	7391	578	24.5
1871............	41	36	54	23	20	7	9	7	17	7	21	39	281	21.5	6059	711	33.0
1872............	40	85	46	27	33	25	15	10	3	17	19	37	348	17.5	6122	573	32.6
1873............	62	55	42	31	37	16	24	12	18	25	20	19	361	20.7	7505	554	26.6
Totals	313	323	337	265	232	132	115	85	136	145	149	226	2452	31.1	76,505	......	......

In 1860, Pneumonia, Pleurisy and Hydrothorax, caused 169 deaths out of a grand total of 7341 deaths from all causes, or 1 death to 998 inhabitants; 1863, 301 in 7172 deaths from all causes, or 1 death in 598 inhabitants; 1864, 440 in 8498 deaths, or 1 death in 395 inhabitants; 1865, 309 in 7016 deaths, or 1 death in 582 inhabitants; 1868, 235 in 5293 deaths, or 1 death in 808 inhabitants. The proportion of deaths from all causes, in the years just given, was, 1860, 1 death in 22.9 inhabitants; 1863, 1 in 23.7; 1869, 1 in 20.5; 1865, 1 in 25.6; 1868, 1 in 35.7 inhabitants.

Deaths from Inflammation and Congestion of the Lungs, (Pneumonia), Pleurisy and Hydrothorax, in New York, with the relations to total deaths from all causes, and the Population of the City, during Fifty Years, 1804–1853, inclusive. Population of New York, **1800, 60,489; 1805, 75,770; 1810, 96,373; 1815, 100,619; 1820, 123,706; 1825, 166,086; 1830, 202,589; 1835, 270,089; 1840, 312,710; 1845, 371,223; 1850, 515,394; 1855, 629,819; 1860, 805,358.**

YEAR.	Total deaths from Inflammation and Congestion of Lungs, Pleurisy and Hydrothorax.	Proportion of deaths from Inflammation and Congestion of Lungs and Pleurisy, in total population. 1 death in	Total deaths from all causes.	Proportion of deaths from all causes, in population. 1 death in	Proportion of deaths from Inflammation and Congestion of Lungs and Pleurisy in total d'ths f'm all causes. d'th in	YEAR.	Total deaths from Inflammation and Congestion of Lungs, Pleurisy and Hydrothorax.	Proportion of deaths from Inflammation and Congestion of Lungs, and Pleurisy, and Hydrothorax in total population. 1 death in	Total deaths from all causes.	Proportion of deaths from all causes, in population. 1 death in	Proportion of deaths from Inflammation and Congestion of Lungs and Pleurisy, in total deaths f'm all causes, 1 d'th in
1804....	99	760	2125	34.3	22	1829.....	290	674	5,094	39.6	18
1805.....	102	742	2344	32.2	23	1830.....	374	841	5,537	36.4	14
1806.....	127	630	2225	35.3	17	1831.....	273	798	6,363	32.6	23
1807.....	138	605	2312	36.2	16	1832.....	428	560	10,359	23.1	24
1808.....	100	887	2014	44.0	20	1833.....	463	548	5,746	44.2	12
1809.....	106	909	2108	44.0	19	1834.....	464	577	9,082	20.2	19
.1810.....	147	655	2167	44.50	14	1835.....	566	477	7,082	39.1	15
1811.....	137	708	2524	38.4	17	1836.....	502	557	8,009	34.9	15
1812.....	122	807	2553	38.1	20	1837.....	589	495	8,732	33.2	14
1813.....	233	421	2283	43.0	9.8	1838.....	685	438	8,053	37.2	11
1814.....	206	483	1974	50 4	9	1839.....	675	453	7.953	38.4	11
1815.....	80	1257	2507	40.1	31	1840.....	570	548	8,474	36.8	14
1816.....	222	473	2739	38.3	12	1841.....	694	468	9,115	35.6	13
1817.....	238	459	2527	43.2	10	1842.....	733	458	9,176	36.6	12
1818.....	192	596	3265	35.0	17	1843.....	709	490	8,693	40.0	12
1819.....	199	595	3176	37.3	16	1844.....	658	543	8,875	40.5	13
1820.....	161	768	3515	40.0	21	1845.....	647	573	10,983	33.8	17
1821.....	132	998	3542	37.2	19	1846.....	974	410	11,318	35.3	11
1822.....	189	742	3231	43.3	17	1847.....	889	481	15,788	27.1	17
1823.....	193	766	3444	42.9	18	1848.....	940	489	15,919	28.8	17
1824.....	225	693	4341	36.1	19	1849.....	1205	402	23,773	20.4	19
1825.....	253	656	5018	33.9	20	1850.....	1272	405	16,978	30.3	13
1826.....	373	461	4973	34.6	13	1851.....	1571	336	23,024	23.9	14
1827.....	434	410	5181	34.3	12	1852.....	1449	372	21,631	24.9	15
1828.....	306	514	5181	36.2	17	1853.....	1514	369	22,702	24.4	13

The total number of Emigrants in New York during a period of fifty years, 1,627,174.
Total deaths during fifty years, 364,695; of which, Pneumonia and Pleurisy caused 23,753, or 1 death in 15.3 from all causes.

Total Deaths from all Causes, amongst Whites and Blacks, and Deaths from Pneumonia, Pleurisy and Hydrothorax, in Philadelphia, Pennsylvania, during a period of 10 *years,* 1831–1840 *inclusive.*

YEAR.	Total Population Whites and Blacks...	General Mortality, Stillborn excluded...	Proportion of General Mortality, to Total Population. One Death in............	Propor'n of Deaths amongst Whites alone 1 Death in............	Propor'n of Deaths among Blacks alone, 1 Death in............	Total Deaths from Pneumonia, Pleurisy, and Hydrothorax......	Propor'n of Deaths f'm Pneumonia, Pleurisy, and Hydrothorax in population. 1 Death in............	Propor'n of Deaths f'm Pneumonia, Pleurisy and Hydrothorax in Deaths from all causes. 1 Death in...
1831........	174,541	4623	37.89	39.6	33.6	292	597	15.9
1832........	179,694	6425	28.21	28.83	22.65	325	583	19.1
1833........	185,000	4128	45.36	47.32	35.28	243	761	17.2
1834........	190,461	4765	40.09	41.46	33.27	247	771	19.4
1835........	196,084	5358	37.39	38.32	31.21	334	587	16.0
1836........	201,976	5022	41.25	43.80	24.47	296	706	17.0
1837........	207,834	4881	43.89	45.16	30.75	321	647	15.3
1838........	213,970	5118	43.27	45.00	29.23	328	656	15.6
1839........	220,287	4765	48.08	49.48	31.30	322	683	14.4
1840........	226,693	4593	49.57	52.28	38.68	297	760	15.3
		48,678	41.15	43.12	31.05	3005		16.1

Out of a grand total of forty-eight thousand six hundred and seventy-eight deaths occurring in Philadelphia, during a period of ten years, 1831–1840, three thousand and five, were caused by Pneumonia, Pleurisy and Hydrothorax, which gives the proportion of 1 death in 16.1 deaths from all causes.

From a careful comparison of the preceding statistics, the following conclusions may be established:

First. The death-rate from Pneumonia, is, both relatively to the total mortality, and absolutely in proportion to the population, less in such cities as Charleston, Savannah and New Orleans, in which the various forms of Malarial Fever are most prevalent and fatal, than in cities situated in the interior, and in the more northern latitudes, and in localities comparatively free from malarial influence, as Augusta Georgia, New York and Philadelphia.

Second. In Charleston, Savannah, Augusta and New Orleans, Pneumonia and Pleurisy prevail most in the coldest and most variable months, when Malarial fevers are comparatively rare.

Third. The preceding statistics, which cover a sufficient period of time and relate to localities widely separated, on the North American Continent, establish, conclusively, that there is no connection between the origin and causation of Pneumonia and the action of that cause, or those causes, which induce or produce the various forms of Malarial fever.

It is, however, true that the action of malaria induces a state of the Human System which modifies the progress of inflammations, and which is characterized by profound changes of the Blood and of the Liver and Spleen, and by periodic congestions of the internal organs, and periodic disturbances of secretions, excretions, circulation, temperature, and nervous and muscular forces. We will proceed, therefore, to present the general results of our investigations on the relations of the action of Malaria on the Human System, to the Symptoms and Progress of Pneumonia.

GENERAL RESULTS OF INVESTIGATIONS ON THE RELATIONS OF THE ACTION OF MALARIA IN THE HUMAN SYSTEM, TO THE SYMPTOMS AND PROGRESS OF PNEUMONIA.

First. *There is no necessary connection between Pneumonia and Malarial Fever.*

In healthy, elevated, non-malarious regions, pneumonia is almost never complicated with malarial fever.

In malarious regions, on the other hand, pneumonia is frequently complicated with malarial fever. The local inflammation frequently appears in those who are laboring under the action of the malarial poison, and the disease partakes of the paroxysmal character.

If the system of healthy individuals be reduced in malarious regions, by any depressing agent or disease, as by the amputation of a limb, or by the inflammation of some organ, as of the lung in pneumonia, the malarial poison is most likely to exert its effects. In such cases, the paroxysmal character of the inflammatory disease is due not to the pre-existing action of the malarial poison, but to the fact that the system has been so depressed as to be unable to resist the action of the malarial poison.

Second. *The Malarial Poison induces profound alterations in the constituents of the Blood.*

Under its action, the colored-blood corpuscles are more rapidly, and to a greater extent, destroyed than in any other disease. The fibrin is diminished and altered in quality. The albumen is in like manner diminished. The extractive and coloring matters of the blood are frequently increased. The unhealthy hue of the complexion in malarial fevers, appears to be due to both the destruction of the colored blood corpuscles and the presence of coloring matters in the blood.

Third. *During the active stages of Malarial Fever, phosphorus, and the compounds of phosphorus in the nervous structures and in the colored blood corpuscles, as well as sulphur and the compounds of sulphur in the muscular structures, undergo more rapid changes than in the normal state, and phosphoric acid and the phosphates, and sulphuric acid and the sulphates appear in increased quantities in the urine.*

The waste of phosphorus and its compounds in the blood corpuscles and nervous structures during the active stages of the fever, is far greater than the supply of these elements through the food.

The nervous disturbances and debility characteristic of malarial fever are, in a measure, if not entirely, due to these rapid changes in the phosphorescent materials of the nervous structures, and especially of the central ganglionic cells.

Fourth. *During the slow action of the Malarial Poison, as well as during the active stages of the paroxysm, important changes take place in the Liver and Spleen.*

In both organs, the colored-blood corpuscles are destroyed in large numbers, and the coloring matter, resulting from the disintegration of the red corpuscles, accumulates in them, and in conjunction with other changes in the nutritive processes of these organs produce those characteristic alterations of the normal color. In fatal cases, cellulose is found in both the liver and spleen, whilst grape sugar is absent from the liver. The bile is altered both in chemical constitution and physical properties.

Fifth. *That the chemistry of the body is still farther deranged in Malarial Fever, is evidenced by the changes in the excretions.*

During the chill, and at the very commencement of the hot stage, phosphoric acid disappears almost entirely from the urine; as the hot stage progresses, and the febrile action and the heat commence to decline, there is an augmentation of phosphoric acid

But what is still more important in its bearings upon pneumonia, the uric acid is increased, or remains at the normal standard, during the chill; disappears almost entirely during the fever; and then increases rapidly, and rises to a high figure, after the subsidence of the febrile excitement, and often continues for days, two, three, and even six times more abundant than in the normal state.

If it be true that the presence of a morbific material in the blood, as uric acid, in gout and rheumatism, will often prove an excitant to inflammatory action, this tendency in malarial fever to the generation of large quantities of uric acid during the intermissions, and even during the period of convalescence, is important in its bearings, not only upon pneumonia, but also upon neuralgic affections.

I have in my own case observed changes in the urine, and especially in the uric acid during severe headaches of malarial origin, similar to those observed in well defined cases of paroxysmal fever.

Sixth. *One of the most marked and important of the phenomena of Malarial Fever, in its connection with inflammations of internal organs, is the congestion of important organs at stated intervals.*

It would even appear that, aside from the general depressing effects of the malarial poison upon the heart and circulatory system at stated periods, and the consequent stagnation of the blood in the central portions of the circulatory system, the altered blood corpuscles, and the products of their death and disintegration, as the coloring matter, may under certain conditions obstruct the smaller vessels, and give rise to local and circumscribed congestions and even effusions.

It results from these effects of the malarial poison:

(a.) When inflammation is excited from any cause, in a system subjected to the influence of the malarial poison, the natural tendency is for the inflammation to assume a low form, from the altered condition of the constituents of the blood and structures, and from the derangement in the processes of nutrition, and of those physical and chemical acts by which the nervous and muscular forces are developed.

It is well known that the causes which are most influential in the production of inflammation are such as enfeeble the heart, impair the tone of the arteries, reduce the activity of the secreting organs, and debilitate the muscular and nervous forces.

Imperfect nourishment also, either in consequence of the defect in the quantity or quality of the food, or of incapacity of the digestive powers, impairs the powers of the system to resist the effects of deleterious and depressing agents, as cold; and produces a liability to low forms of inflammation and fever, and to various epidemic and contagious disorders.

In malarial fever, even when the digestion is unimpaired, the action of the poison, by impairing the constitution of the blood, and by deranging the nutritive processes of the different organs and tissues, and by deranging and depressing the chemical actions concerned in the development of the physical and nervous forces, produces similar results to those witnessed in ill-fed and ill-conditioned beings.

The process of inflammation, whilst including both congestion and determination of blood, is essentially more complex than either or both of these conditions, and includes changes of the blood within the vessels, and changes of the relations of the capillaries to the blood, and of the blood to the surrounding tissues.

The character of these changes, as well as the extent and progress of the inflammation, will depend upon the constitution of the blood, the forces moving that blood, and the condition of the forces active in the nutrition of all the organs, as well as of the forces especially active in the inflamed tissue. Thus, when the character of the blood has been altered and the forces depressed, the solid products of inflammation are less capable of organization, the lymph effused possesses inferior plasticity, and the effects of the local inflammation upon the general system, in causing inflammatory fever, are more depressing and dangerous. As therefore the tendency of the malarial poison is to derange the conditions upon which the maintenance of healthy nutrition depends, viz: the regular supply of healthy blood possessing a definite composition and relation of its elements, and of a certain supply of physical and nervous force, and the healthy constitution of the organs and tissues, it is evident, not only that inflammation engrafted upon the system laboring under the effects, or under the direct action of the poison, must be correspondingly altered from its progress in the healthy constitution, but also that the state of the system induced by the action of the malarial poison is conducive to the origin of inflammation.

(b.) From the destruction of the fibrin and red blood corpuscles, consequent upon the action of the malarial poison, the tendency of inflammations excited in systems under the influence of the malarial poison is to diffusion.

The increase of fibrin in the blood, and in the inflamed structures, appears to be destined, in the economy of nature, to limit and circumscribe the inflammatory action, by the fibrinous matter thrown out within and around the inflamed part.

The colored blood corpuscles, which crowd the inflamed part, appear to contribute by the chemical changes which they excite, and especially by the increased oxidization of the protean elements, to the formation of fibrin, which in this view may be considered as one of the controlling and limiting elements of inflammation. Whatever therefore tends to diminish the red corpuscles and fibrin, tends to interfere with the natural processes employed by nature in the limitation of inflammation, and directly promotes the diffusion of the inflammation over a greater extent of tissue, and in a corresponding degree renders it more severe and dangerous.

We have in these facts an explanation of the sudden and fatal character of many cases of pneumonia occurring in those who have been for some time under the influence of the malarial poison.

We have had under treatment, and recorded at length elsewhere, cases which were suddenly seized with pneumonia during the period of convalescence from malarial fever. These patients were destroyed, or rather drowned, by the rapid pouring out of serous fluid into the air cells and bronchial tubes of the lungs. In such cases the capillaries of the blood, being in an enfeebled state, the fibrin of the blood being diminished in quantity and altered in physical and chemical properties, the colored blood corpuscles being diminished in number and physically and chemically altered, the solid matters of the blood having been diminished, and the physical and chemical relations between the individual constituents of the blood and capillaries having been disturbed by the action of the malarial poison, healthy limited inflammation was impossible.

Diffused inflammation of all the structures of the lung resulted; the serous portion of the blood poured into the air cells, bronchial tubes and trachea; the supplies of oxygen were in a great measure cut off; the chemical changes of the solids and fluids were in a corresponding degree checked; and the physical forces, heat, and electricity, and the nervous force, developed by these changes, were, as a necessary consequence, correspondingly diminished.

Broussais in his history of chronic phlegmasiæ, has recorded several analogous cases of fatal pleuritic and pulmonic affections attacking those suffering with malarial fever; and Andral, in his "Clinique Medicale," has given at length a fatal case of pneumonia, with pulmonary œdema and double pleuritic effusion following and supervening upon intermittent fever.

The following cases, 710 and 711 treated by me (1857,) in the Savannah Marine Hospital and Poor House, will illustrate the influence of the Malarial Poison on the progress of inflammation in special structures.

Case 710: Irishman, age 26; height, 5 feet 11 inches; weight, 170 pounds; black hair; black eyes; full, dark brown beard and moustache. Limbs full and round, chest broad and well developed. Has been in America, (New York) nine years, and in Savannah three months. During this time he has followed the occupation of a baker.

September 11, 12 M., 1857. Has just entered the Savannah Hospital with Remittent fever. Pulse accelerated but feeble, and his complexion shows the effects of malarial fever. Says that he has been sick for one week, and has been living near the depot of the Albany and Gulf Rail Road, in a low malarious situation. Under the action of Sulphate of Quinia and stimulants, the febrile excitement disappeared in the course of four days; the patient however, was left in a very feeble condition; complained of great weakness, his pulse was feeble, the action of the intellect sluggish, and he had a peculiarly disagreeable smell, which was not permanently removed, either by water, or by change of clothing. Under the action of tonics he recovered sufficiently to walk about the yard; but continued however, weak, low spirited, and indisposed to action.

September 27th. Complained of torpor of the bowels. A mild Cathartic was administered.

September 28th. Has a cough. The wind has been from the North East for some time, and the weather has been cold and damp, and epidemic catarrh is prevailing. About two-thirds of the hundred patients now in the hospital are suffering with the influenza.

This patient was up and about the wards, assisting and nursing the patients all day. He was up and about, when I went the rounds of the wards at 9 o'clock P. M. Shortly after this he complained of great oppression of the lungs, difficulty of breathing, and loss of muscular power.

29th, 9 o'clock A. M. During the night took a sudden and remarkable change for the worse. Respiration spasmodic, and sounds as if the air cells, bronchial tubes and trachea contained

antities of fluid, and is attended with a loud rattling sound, in the thorax. The
, rattling, gurgling, crackling sounds of the lungs and trachea are very loud, and can
nctly heard over the upper wards of the hospital. Muscular power completely
d; lies upon his back, and is unable to turn upon either side. Surface of extremities
rface of trunk cool, several degrees below the normal standard. The temperature of
mities does not differ essentially from that of the surrounding medium. The expres-
is eyes and countenance, and his efforts to converse, show that he is inteliigent; he
er entirely unable to articulate and expectorate.

sms were applied to the extremities, epigastric region and chest, and stimulants were
ered freely. These did not present any beneficial effects—did not arouse the circula-
did not increase the animal temperature, because the supply of oxygen necessary
hemical changes which generated the physical, muscular and nervous forces were
The mustard scarcely reddened the skin, even after the application for several

atient continued in this state, with a gradual diminution of power, until 1 o'clock, A.
ext morning, when the painful respiratory sounds were hushed in death.

y eight hours after death. Exterior:—Body in good condition, not emaciated; limbs
round; muscles of trunk and extremities covered by a thick layer of fat; face and
llow and sunburnt: surface of the skin, which had been covered by the clothes,

—Dura-mater presented the usual appearance. Arachnoid membrane transparent and
blood-vessels of pia-mater filled with blood. When the dura-mater was removed, an
the substance of the brain was discovered, occupying a position near the centre of
rior surface of the left hemisphere of the cerebrum. This ulcer was three-fourths of
n length, half an inch in breadth, and one-eighth of an inch in depth. The walls were
d and much harder than the surrounding brain. The blood-vessels of the surrounding
r and brain were congested with blood, and a small quantity of bloody serum was effused
the arachnoid and pia-mater in the immediate neighborhood of the ulcer, but nowhere
e appearance of the ulcer, and the congestion of the blood-vessels around by no means
d for the death of the patient. The thickened walls, the absence of pus, and the sound
he structures of the brain around, show not only that the ulcer was of long standing,
that it was rapidly healing. The existence of this ulcer will account, in part, for the
argic state of the intellectual faculties, but not for the death of the patient. The
s of the brain contained a small quantity of clear serum. The structures of the brain
the usual consistence and appearance.

—Heart normal in size; the right ventricle contained a large, yellow fibrinous clot,
to the chordæ tendineæ and carnæ columnæ, and extended through the auriculo-
ar opening into the auricle.

lot was firm in texture, and weighed one ounce. The left ventricle contained a small
low clot; the aorta also contained a small, flattened, ribbon-like, light-yellow clot.
ots were evidently formed previous to death, when the circulation was exceedingly

:—The lungs were greatly distended and did not collapse in the slightest perceptible de-
en air was admitted in the pleura. They were congested with blood, and resembled
nd when handled, they were remarkably heavy, and felt more like liver than lungs.
ut, the air cells, and large and small bronchial tubes, were found filled with serous
d numerous fine bubbles of air. When the lungs were squeezed, pints of this serous
wed out. In many portions of the lungs the serous fluid was clear; in others it was
The fluid resembled serum in all respects, and was not mucus. Here, then, we
cause of the death of this patient. He was drowned.

inal Cavity:—Stomach pale, and perfectly healthy in appearance; intestinal canal,
stomach to the anus, pale and healthy in appearance.

—The normal reddish-brown color of the liver, was changed in most parts, to a mix-
ight bronze and light olive, and, in several places, resembled the normal color. In
lar spots, about three inches in diameter, the liver was of a dark, bluish-slate color,
of a recent case of malarial fever.

t surface of the liver approached more nearly to the normal color than the exterior.
d of the liver, after exposure to the atmosphere, assumed a red arterial color. It is
from this examination, that the structures of the liver were recovering from the effects
alarial fever, and that the organ was regaining its normal color.

:—Slate colored, enlarged and softened. The pulp of the spleen presented a dark
-brown color, which did not change to the red arterial color as rapidly as the pulp of
spleens; the change of color, however, was much greater than that of the pulp of the
recent cases of malarial fever. This organ, like the liver, appeared to be recovering
effects of malarial fever.

ys:—Healthy.

We believe that we have now all the facts necessary for a rational explanation of the phenomena presented by this case.

The malarious poison, and its effects, had produced profound alterations in the blood and capillaries, liver and spleen, and primarily by its action, or secondarily by the action of the altered products in the blood, affected the sympathetic and cerebro-spinal nervous systems. The patient, although weak and lethargic on account of these pathological alterations and the ulcer upon the brain, was, nevertheless, in a fair way of recovery; the alimentary canal had resumed its healthy actions, and the liver and spleen were fast recovering, and he was gaining strength daily. We can, in view of these facts, safely assert that if no other disease had occurred, the lesion of the left hemisphere of the brain, and the effects of the malarial poison, would not have proved fatal.

In this state of slow convalescence, the patient was suddenly seized with the prevailing influenza. The mucous membrane of the bronchial tubes and air cells was irritated. The irritation of the mucous membrane was followed by congestion of the blood-vessels and capillaries of the lungs. The capillaries were in an enfeebled state; the fibrin of the blood was diminished in quantity, and altered in physical and chemical properties; the colored blood corpuscles were diminished in number, and physically and chemically altered; the solid matters of the blood were diminished; and the physical and chemical relations between the individual constituents of the blood and capillaries were disturbed. Healthy, limited inflammation was impossible. Diffused inflammation of all the structures of the lungs resulted; the serous portion of the blood poured into the air-cells, bronchial tubes and trachea; the supply of oxygen was in a great measure cut off; the chemical changes of the solids and fluids in a corresponding degree checked; the physical forces, heat and electricity, and the nervous force, developed by the chemical changes were, as a necessary consequence, correspondingly diminished. The immediate cause of the death of this patient, was a deprivation of oxygen and the retention of carbonic acid gas. We may say, with truth, that he was drowned.

Case 711: Irishman, laborer and boatman; age 30; height 6 feet; weight 150 pounds; tall, spare frame, light hair, blue eyes; pale, sallow complexion. Has been running on flat boats and rafts, up and down the Savannah River, between Savannah and Augusta, for the last twelve months. Habits irregular; addicted to the use of ardent spirits. Says that his constitution has suffered much from the exposure to the hot sun and night air on the river, and also from an intemperate use of ardent spirits.

September 20th, 1857. A flat, laden with wood, which he was bringing to the city was sunk in shoal water. He was all day in the water up to his waist, fishing out the wood; and at night had a chill, followed by fever. The fever went off before morning, and on the next day he was employed again in the water. The chill returned at night, and was followed by high fever. Has been sick from that day to the present time, September 27th, without any medical attendance. Pulse 106; respiration accelerated, labored; skin hot and dry; countenance distressed; has a haggard, anxious look; complains of great thirst, of pains in his back and bones, and of great exhaustion. His pulse although rapid is feeble, and his forces appear to be completely exhausted. His fever remitted slightly on the next day, but returned on the 29th inst. Under the action of large doses of Sulphate of Quinia, and Sinapisms. Stimulants, (snake root tea, milk punch, wine, whisky and brandy,) the febrile excitement subsided, the urine regained its normal hue, and on the 4th inst., of the following month, his pulse was 70 and respiration 18; temperature normal and function of skin normal, and although apparently very weak, the patient was able to be up and about the ward. During the attack the saliva was acid, and the urine copious; from 20,000 to 25,000 grains were excreted daily. The specific gravity was correspondingly low, from 1012 to 1024. The abundant discharge of urine was due to the large quantities of water which his thirst led him to take, and also to the diuretic action of the infusion of snake root. Throughout the attack his pulse was feeble, and his forces greatly exhausted, and he required close attention, and the free administration of Stimulants.

October 5th. This morning, escaped clandestinely from the hospital.

8th. Has returned. Pulse 120; skin hot and dry; respiration accelerated, labored; complains of great pain in the back of his head and neck; these parts are swollen and painful upon pressure. (Cold water dressing to back of head and neck).

9th. His head has been shaved, and the tissues above the occipital bone, and above the left temporal and parietal bones are swollen, and the skin looks black, and is ulcerated in several places. The swelling extends down along the neck, and reaches the superior portion of the left shoulder. To the finger the swollen parts feel as if there was a collection of fluid beneath the skin. Says that he is suffering intense pain; countenance distressed and haggard; pulse 128; skin hot and dry; respiration thoracic, labored, accelerated.

10th. Pulse 160, feeble; skin hot; respiration spasmodic and labored. In addition to the intense pain in the back of his neck and left side of the head, he complains of intense pain in his chest. The pain in the chest cuts short the respiration, and renders it spasmodic. His countenance is expressive of great agony and terror.

11th. Pulse 140, rapid and very feeble; respiration 24, labored, thoracic, spasmodic. The pain in his chest is intense; he groans and cries out at every breath, and the expression of his countenance is indicative of great agony, terror and horror. Was restless and delirious during the night, and during his delirious visions spoke and acted as if he was engaged in mortal combat. Has no hope of himself, and refuses all medicine. The back of his neck and side of head is much swollen, and when pressed with the hand there is distinct fluctuation. Hoping that discharge of the pus or fluid, would afford relief, a free crucial incision was made at the most prominent part of the swelling. Nothing but blood issued. The hæmorrhage was so great, that it was necessary to check it by the application to the wound of a compress, saturated with Tincture of Muriate of Iron.

12th. During the night was delirious; would rip out the most terrible oaths, and cry out that the devils were after him; had beaten him severely, and were endeavoring to throw him out of the windows. At other times he would speak and act as if he had been in mortal combat, and was wreaking vengeance upon an imaginary antagonist. These actions excited the suspicion that the injury on the back and side of the head was received from a blow.

The patient died at one o'clock A. M.

Autopsy nine hours after death. Exterior.—Body much emaciated; back and side of neck much swollen. The inferior surface of the trunk and neck presented a mottled appearance from the settling of the blood by gravitation during the last hours, when the circulation was feeble. On the right leg there were the marks of an extensive ulcer upon the skin covering the tibia; the cicatrix presented a purplish, angry color. When incisions were made into the swollen parts of his neck, and back and side of head, the spaces between the muscles, the meshes of the fibrous tissue surrounding and connecting together the muscles and the fibrous tissue of the skin, was found to be completely filled and distended with golden colored serum.

Head.—Dura-mater healthy. Arachnoid membrane transparent throughout its entire extent over the hemispheres of the brain. At the base of the brain, it was slightly opalescent. Blood-vessels of pia-mater, not more filled with blood than usual. The cortical and medullary substances of the cerebrum and cerebellum, and the structures of the pons varolii, the medulla oblongata and superior portion of the spinal marrow, appeared natural in consistence and color. Ventricles of brain contained 10 fluiddrachms of golden colored serum. The superior longitudinal sinus of the dura-mater contained a golden yellow, elongated clot, the diameter of which was about one-half that of the longitudinal sinus.

Chest.—Heart somewhat enlarged. Pericardium contained one fluidounce of golden serum. All the cavities of the heart contained golden colored clots. The right auricle had a large golden colored clot, which was attached to the carnæ columnæ and chordæ tendineæ of the auriculo-ventricular valves. The aorta and carotids, and pulmonary arteries contained elongated golden colored clots, having diameters nearly equal to these of the arteries. All those clots were firm and elastic.

Lungs.—The lungs did not collapse when the cavity of the chest was opened. Exterior surface of the pleura covering the lungs, and lining the walls of the thorax, was covered with soft coagulable lymph of a golden yellow color. Adhesions were numerous, but as yet, not strong, on account of the soft, fresh condition of the coagulable lymph, which was evidently but recently effused, probably within the last seventy hours. This inflammation of the pleura occasioned the severe pain in the chest during life. The lungs were much congested with blood, and when cut, they resembled liver. The bronchial tubes and air cells, contained much serum. This serum poured in large quantities from the cut surface. The anterior surface of the middle lobule of the right lung had a dark blackish, red spot, about one inch in diameter, which resembled at first sight a wound from a sharp instrument. An examination of the exterior of the chest, and interior surface of the ribs, showed neither wound nor fracture of the ribs. When closely examined, this portion of the lung were found to be more congested and solidified than the surrounding portions.

Abdominal Cavity.—Alimentary Canal. The stomach although enormously distended with gas, was pale and healthy in appearance. Small intestines also pale and healthy to the naked eye. Liver of a light, bronze color. The color is lighter than that of the liver in the active stages of malarial fever, but resembles the color of a liver which was recovering from the effects of malarial fever. Cut surface of a light, bronze color, and not of such a deep and decided bronze as the liver in the active stages of malarial fever. The right lobe of the liver had upon its under surface a slate colored spot, three inches in diameter, which resembled in all respects the liver of a recent case. When an incision was made across this spot, the cut surface presented for one sixth of an inch, the true malarial hue; below this, it approached more nearly the normal hue. The structures of the liver did not appear to be softened.

Spleen.—Much enlarged, of a dark, slate color, and although much softer than a normal spleen, it was much harder than a spleen of a recent case of malarial fever. Weight, 3 ounces. This organ, like the liver, appeared to be just recovering from the effects of malarial fever. Kidneys appeared to be somewhat enlarged; the calices infundibula and pelvis of the kidney contained a small quantity of a thick yellow fluid.

The following appears to be the cause and history of the last attack:

The patient left the hospital when he was in an exceedingly feeble condition, after a severe attack of Remittent fever. It is probable that he indulged his taste for ardent spirits; for the day on which he left the hospital was "Election Day."

The wind was from the northeast, and the weather damp and cool, with occasional scuds of rain and mist. Exposure to this cool, damp wind, fresh from the ocean, and the low-grounds and swamps of Georgia and South Carolina, not only during the day, but probably during the night also, in a state of intoxication, induced a severe attack of pleuro-pneumonia.

The swelling on the back of his head was due either to a blow, or to inflammation in the cellular tissue and muscles, analogous to the inflammation of the lungs, and probably arising from the same cause.

The large amount of serum effused into the bronchial tubes; the large amount of golden colored serum effused into the cellular tissue of the neck and head, and the large golden fibrous clots in the heart and arteries; the settling of the blood in the most dependent parts of the body; the appearance of the cicatrix, and the inflamed spot in the lungs, all indicate disturbances in the constitution of the fibrin, and of the relations between this element and the other elements of the blood to each other, and to the blood-vessels and capillaries.

Andral, in his "Clinique Medicale," gives the following interesting case of Pneumonia, with pulmonary œdema, and double pleuritic effusion, following Intermittent fever:

Case 712.—A man about fifty-eight years of age, of a strong make, was seized the 8th of August, 1822, at 8 o'clock in the morning, with a violent shivering, which, at the end of an hour, was followed by heat, then by a profuse sweat. On the 9th, there was apyrexia. The 12th, the patient entered La Charité. We saw him at the beginning of the third accession; he felt icy cold in the trunk and extremities; however, the skin was burning hot; pulse hard and frequent. At nine o'clock, the sensation of cold was succeeded by a sensation of burning heat, and sweating soon set in. Twelve grains of Sulphate of Quinine were prescribed for the next day, the 13th, to be taken in three doses, at noon, at 4 o'clock, and at 8 o'clock at night. On the morning of the 14th, the patient no longer felt any shivering, but merely a little heat, with some frequency of pulse. On the 15th, apyrexia. On the 16th, the day of the fever, at 10 in the morning, the patient felt a slight shivering, then he was seized with a burning heat over all the right side of the thorax, from the last ribs to the axilla. The pain, which was augmented by the slightest motion, did not cease till 10 o'clock at night. In the night a profuse sweat took place.

In the morning there was great dyspnœa; speech short and panting; decubitus on the back. The pain of the preceding day had not reappeared, but the patient expectorated three or four viscid, transparent sputa, of a greenish yellow color. A well marked, crepitous râle was heard on the right, anteriorly and laterally. Posteriorly, on both sides, the respiration was very loud, sufficiently clear, mixed in some points only, and at intervals, with a crepitous râle; it was the same on the left anteriorly. Pulse frequent and hard; skin hot and dry; tongue whitish; diarrhœa. (He was bled to eight ounces). The blood presented a large crassamentum, without a coat. On the 18th, a loud, crepitous râle was heard over all the parts of the chest; percussion elicited everywhere a clear sound, except low down on both sides, from the sixth or seventh rib. The pneumonic characters of the expectoration still continued. Pulse, 110; forty-three respirations in a minute; the tongue was dry and pale. (Another bleeding to eight ounces; sinapisms to the legs) A thick, greenish coat on the surface of the crassamentum. On the 19th his state was the same. He died the next morning.

Post-mortem.—On cutting into the tissue of the two lungs, an enormous quantity of frothy, colorless serum was seen to gush out from every part. The pulmonary parenchyma was everywhere of a grayish white color, and crepitated perfectly, except near the right lung. In this latter part there was observed in separate patches a tissue of a livid, red color, which did not crepitate, and was very easily torn. These different inflamed portions combined, would scarcely have equalled the size of an orange. On the left, from the level of the seventh or eighth rib to the diaphragm, the lung was separated from the thoracic parietes by a liquid of a deep red color, the quantity of which scarcely equalled half a pint. Superiorly, false membranes, of recent formation, limited this effusion, and united the lung to the ribs. On the right, there existed another effusion similar to the preceding, with respect to its being circumscribed, and also with respect to the quantity of the liquid, but which differed from it with respect to the quantities of the latter. It was a turbid serum, in the midst of which a considerable number of albuminous flocculi floated. A black, coagulated blood filled the four cavities of the heart, and distended the right auricle in particular.

When this patient entered La Charité, he was afflicted with an intermittent fever, exempt from all serious complication. The fourth fit was prevented by Sulphate of Quinine. Towards the time when the fifth should have returned, the shivering and pain of side marked the invasion of the pleuritis on the right side; the respiration soon became embarrassed; some crepitous râle was heard at first in some parts, then over almost all the thorax; finally, pneumonic sputa appeared. The general existence of the crepitous râle seemed to announce a general inflammatory engorgement of the two lungs; there was no such thing, however, and the autopsy proved that this râle was due to serous effusion.

(*c.*) The liability of persons who have suffered with malarial fever in the summer and fall, to be seized with Pneumonia in the winter and spring, and the danger of these inflammatory attacks, following or engrafted upon paroxysmal fever, have long been known to the public, as well as to the profession.

In many cases, these inflammations, engrafted upon malarial fever, or following its effects, are clearly dependent for their excitation upon the vicissitudes of the weather, and especially upon the agency of cold.

In healthy beings exposed to cold, there is at first, through the stimulating effects of the cold air inspired, and of the change of temperature upon the exterior, an increase in the circulatory and respiratory actions; more oxygen is introduced and distributed, the chemical changes of the system become more rapid, and the temperature of the body, notwithstanding the increased radiation and loss of heat, is maintained at the normal standard by the increased chemical actions. As long as the fixed normal temperature of health is maintained in the trunk and important organs of animal and vegetable life, no evil results follow. If, however, through the prolonged action of the cold, the materials capable of keeping up the temperature be exhausted, or if the nervous and muscular forces be so depressed that the respiratory and circulatory actions are so impaired that the materials are not distributed with sufficient volume and celerity to maintain the necessary chemical changes to preserve a fixed temperature, the heat of the body gradually descends, not only by progressive conduction and radiation from the exterior to the centre, as in an inanimate cooling body, but the chilled blood circulating in the vessels of the exterior, and in the capillaries of the lungs, mingles with the mass of blood in the interior, and still farther and more rapidly reduces the temperature of the great central organs. At the same time, the contraction of the vessels distributed through the superficial structures, under the prolonged action of cold, forces the blood inward toward the largest venous receptacles, and thus induces a state of congestion in the central organs.

It is a well established fact, that a fixed temperature is absolutely necessary to the maintenance of the healthy nutrition of the tissues, to the proper performance of the functions of secretion and excretion, and to the regular and active development of the nervous and muscular forces. Not only by the congestion of the internal organs, but also by the disturbances induced in the chemical and physical processes concerned in secretion and excretion, by the loss of that amount of heat or physical force which is one of the essential conditions to those actions, do those changes in the mutual relations and constitution of the blood, and capillaries, and organs ensue, which frequently result in the establishment of inflammation. And it is not unreasonable to suppose that during such disturbances, chemical products may be formed of a totally different character from those of the healthy organism; just as in the laboratory, with the same organic materials, different products are formed under different degrees of heat; and also, that the excrementitious matters necessarily resulting from the nutrition of the organs and development of the forces may be retained in the blood and structures, from the congestion of the kidneys, and the impairment, if not total cessation of the function of the skin, consequent upon the constriction of its pores and vessels and diminution of its nervous supplies, following the reduction of temperature; and still farther, that these altered products and excrementitious matters may irritate certain organs and excite in them inflammation.

As therefore, the malarial poison destroys those constituents of the blood and nervous system most intimately associated with, and necessary to, the generation of heat, and of all the nervous and physical forces, and as it farther depresses the nervous and muscular forces, and the action of the heart, and the tonicity of the arteries, and tends of itself to induce congestions of the internal organs, it is evident that it renders its victims, when exposed to the vicissitudes of weather, and especially to the prolonged action of cold, exceedingly liable to inflammations.

(*d.*) The action of the malarial poison is attended, not only with derangement in various nutritive processes, but also with the generation of increased quantities of the urates.

In like manner, in inflammations existing in healthy organizations, when resolution takes place, there is an increased excretion of the urates.

If, therefore, the existence in the blood, and non-elimination of these excrementitious bodies in certain diseases, as gout and rheumatism, tend to excite local inflammations, it is but reasonable to suppose that their non-elimination from any cause, as from the effects of cold, previously described, may, in like manner tend to excite local inflammations in those suffering from the effects of the malarial poison.

(*e.*) After the excitation of Pneumonic Inflammation from any cause, the periodic changes, and especially the periodic congestions of the internal organs, induced by the action of the malarial poison, tend to aggravate and increase the inflammation.

During the cold stage, the blood stagnates, and accumulates in the capillaries of important organs, because the blood has been altered by the malarial poison and the changes which it induces: because the relations between the blood and its containing vessels, especially the capillaries, have been disturbed; because the regular normal chemical changes necessary for the development of the forces which work the machinery are not generated with sufficient energy, or if generated, with even increased energy, they are not generated in the right position and in the proper quantities, and the correlation of the physical, chemical, nervous and vital forces is thus deranged; because the action of the sympathetic nervous system which accompanies the blood-vessels, and regulates the circulation, and respiration, and secretion. and nutrition, and excretion, and relates them to each other, and to the cerebro-spinal system, has been disturbed by the direct and indirect action of the poison, by the direct action of the poison upon the sympathetic and cerebro-spinal nervous systems, or by the relations of the chemical changes induced, or the products generated in the constituents of the blood by the malarial poison, to the sympathetic and cerebro-spinal nervous systems.

From these facts and considerations, we arrive at the following practical conclusions:

First. Whilst the malarial poison cannot be said directly to produce pneumonia, still it is capable of inducing such changes in the blood, and in the nutritive and excretory processes, as to predispose the system to this and other inflammations. And therefore,

Secondly. The physician should never in the treatment of pneumonia, in those who have been exposed to the action of malaria, lose sight of its effects in complicating inflammation of the lungs, and of the consequent necessity of arresting at once, if possible, the farther action of the malarial poison.

As no remedy can compare with quinine for the accomplishment of this result, its use would in the present state of our knowledge appear to be imperatively demanded in the treatment of pneumonia arising in malarious regions, and presenting well marked and recurrent paroxysms.

This remedy may be indicated even when the patient has exhibited none of the symptoms of malarial fever, before the appearance of inflammation, for it is well established that the malarial poison may be present in the system without manifesting any effects sufficient to excite the attention of the physician or patient. Thus, mechanical injuries in those who have been exposed to the action of malaria are frequently attended with the appearance of paroxysmal fever. Whilst the strength was unimpaired, the system resisted the morbid influences of the poison; but when the forces were reduced, by the injury and the consequent inflammation, then the effects of the poison were manifest. In like manner the depressing effects of the pneumonic inflammation may so weaken the forces as to bring the system under the dominion of a poison, which it had before resisted.

Thirdly. In the treatment of pneumonia in malarious districts, the physician should never forget the similarity, in some important respects, between the effects of the malarial poison and general blood-letting.

The malarial poison, whatever it be, destroys rapidly the colored blood corpuscles. Whatever, therefore, diminishes the colored blood corpuscles, acts in concert with the malarial poison.

General blood-letting more rapidly diminishes these important constituents of the blood. so essential to healthy nutrition, to the maintenance of the nervous and muscular forces, and to the successful progress and resolution of inflammation; because the colored blood corpuscles rush along chiefly in the centre of the vessels, and are evacuated more abundantly than the other constituents of the blood.

The malarial poison also reduces rapidly the forces.

General blood-letting reduces rapidly the forces.

The two, in this particular, again act in concert.

We would not, however, deny that circumstances may arise where blood-letting, and especially local blood-letting, would be beneficial in malarial fever, and in pneumonia complicating this disease. Whenever blood-letting is used it should be borne in mind that it does not, and cannot, cure malarious disease; its beneficial action is only temporary, and so far from curing the disease, the relief which it has temporarily afforded will vanish, if other remedies, especially the sulphate of quinia, be not used; and as a general rule, without these remedies, the patient will be in a much worse condition than if the blood-letting had not been employed.

In considering the use of general blood-letting in malarial fever, we should ever remember that the cerebral symptoms, the delirium and the torpor of the intellectual faculties, and the congestion of the internal organs, are not inflammatory; they are not due to an exaltation of the functions, or to an irritation of the congested organs, but rather to a loss of power in the circulatory apparatus, heart, arteries, capillaries, and veins, and to disturbances in the physical, chemical and nervous forces. Hence, therefore, in pneumonia, complicated with malarial fever, we will best guard against those dangerous periodic changes and congestions, not by depleting, but by stimulating and anti-periodic remedies.

Fourthly. It results from all this, that stimulants and nutritious diet are especially indicated in pneumonia, complicated with paroxysmal fever.

The nutritious diet supplies the elements of the blood which have been destroyed; and the stimulants not only arouse the depressed nervous system, and through the sympathetic and cerebro-spinal gangila, excite the circulatory system to a full and salutary action for the introduction and distribution of the elements of nutrition and secretion so necessary to the favorable progress and termination of all inflammations, but they also preserve the elements of the blood and tissues from too rapid chemical change and destruction, by taking their places, and themselves undergoing the chemical changes which are for the development of the physical forces which work the machinery.

Fifthly. Quinine may arrest inflammations, or promote their resolution by other modes than its anti-periodic powers, as by its sedative and excretory powers, or by its nfluence on the nervous system and capillary and general circulations.

If the value of this agent in the treatment of inflammation depends upon some such power other than its anti-periodic effects, then the important result is reached, that this remedy is valuable in non-malarious, as well as in malarious regions.

Upon this question, however, we need definite experiments and investigations.

We hope, at some future time, to present the results of experiments upon the effects of quinine, both upon the healthy and diseased organism, designed to elucidate those important questions concerning its mode of action.

Finally. We need, above all things, careful records of the results of the treatment of pneumonia with quinine in full doses.

As far as my knowledge extends, no well established data exists by which we may determine the relative merits of this agent in the treatment of pneumonia. I have heard experienced and intelligent physicians affirm that, in private practice, when this drug was used energetically in the early stages of the disease, not more than one case in fifty would prove fatal. This is surely an extraordinary result, and far different from the results of the treatment of pneumonia in the Confederate hospitals, which, it must be confessed, as shown by the hospital records themselves, are bad enough; and in fact, no better, and even worse, than the heavy mortality characteristic of the rigid antiphlogistic method with bleeding, blistering, calomel, and opium and tartar emetic. The Confederate Surgeons did not use blood-letting to any extent in the treatment of pneumonia, and in many cases of this disease employed quinine, stimulants, and nutritious diet.

In our own practice, civil and military, we have used quinine freely in the treatment of pneumonia, and especially in those cases which were complicated with malarial fever, and apparently with marked benefit and highly favorable results, but we are inclined to the opinion that a large share of this success was due to two facts, viz: quinine, a comparatively innoxious, and at the same time a tonic medicine, was substituted for the heroic and poisonous drugs so extensively employed in the treatment of pneumonia, and our patients were supplied with nutritious diet, and the strength was supported; in other words, depressing agents were withheld, the strength was supported, and nature was allowed to have her perfect work.

The Confederate statistics demonstrate that but little confidence can be placed in the dogmatic assertions of practitioners, apart from a careful record of cases and the preservation of the actual statistics.

The careful determination of the value of quinine in the treatment of pneumonia, as well as the best mode and period of its administration, as well as the relative action of this agent in malarious and non-malarious regions, should engage the careful attention of Southern physicians.

In the institution of any investigations into the relative value of quinine in the treatment of pneumonia, the following well-established facts are worthy of constant consideration.

Uncomplicated pneumonia, especially in young and vigorous constitutions, almost always gets well, if instead of being lowered, the vital powers are supported, and the excretion of effete products assisted.

From the accounts which have been published concerning the natural progress of pneumonia, it would appear that very slight cases of limited inflammation may be convalescent on the seventh day; that the majority of cases of medium intensity recover between the seventh and fourteenth days, and very severe ones between the fourteenth and twenty-first days.

In the report of the cases, the extent and character of the inflammation, together with the symptoms, progress, complications, and termination of the disease, as well as the exact period of its commencement and the establishment of convalescence, should be noted with scrupulous accuracy.

Without the careful record of these points, the value of such investigations will be greatly impaired.

Guided by the preceding principles, the general plan which I have pursued in the atment of Pneumonia, has been as follows:

Absolute rest and quiet in a well ventilated room of mild but equable temperature. When in the commencement of the disease, the bowels are constipated, they should be roughly evacuated. In an adult eight grains of Calomel, or ten grains of Blue ss, followed if necessary with Castor Oil, or a Saline purgative in from four to six urs, will generally be found sufficient to unload the bowels. During the progress of disease, it will generally be sufficient to procure one or more actions from the bowels ry second or third day according to the constitution and habit of the patient. The vels may be kept open by gentle saline purgatives or enemas. When diarrhoea ompanies pneumonia, it should not be suddenly checked, but should be controlled by h remedies as Opium, Bismuth and Ipecac.

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The experiments of Binz are especially important in their bearing on the question of the direct action of quinine on the chemical changes of the blood, or of its indirect action through the nervous system, which show that when putrefying liquids are injected into the circulation, the temperature of the body rises; but if the fluids be previously mixed with quinine, whereby the putrefactive processes are arrested or destroyed, the rise in temperature is either entirely arrested or considerably diminished. Such experiments, not only throw light upon the therapeutic action of such alkaloids as quinine, but they also illustrate, as it were, the very nature of the processes of those diseases, the effects of which they modify or counteract by the peculiar chain of chemical actions which they induce in the blood.

I have employed Dover's Powder in the treatment of Pneumonia, for the sedative effects of the Opium, the expectorant effects of the Ipecac, and the diuretic properties of the Sulphate of Potassa.

While local blood-letting, by means of cut-cups, applied over the region of the diseased pulmonary structures may be used, general blood-letting should be employed with caution in malarious regions, on account of its depressing effects on the heart and nervous system; there are cases, however, of a sthenic character, in which general blood-letting may prove of decided benefit.

As far as my experience extends, the Tincture of Yellow Jassamine (Gelseminum Sempervirens), diminishes the frequency and force of the heart's action, diminishes the frequency of respiration, promotes free diuresis, and directly reduces the animal temperature, and acts as a sedative to the nervous system.

Whatever treatment may be adopted in pneumonia, attention to diet is of prime importance. The strength of the patient should be maintained, and the materials for the proper constitution and regeneration of the blood, and development and changes of the products of inflammation, should be supplied in sufficient quantities at short and regular intervals. Milk, and concentrated beef and chicken tea, should hold the highest place amongst the aliments employed during the active stages of pneumonia.

In private practice, the proportion of deaths under the preceding plan of treatment has not exceeded three per cent.

It is my experience, that in hospital practice, the rate of mortality in pneumonia is greatly increased by the following causes:

First. The severest cases, as a general rule, are sent to the hospital; and the proportion of Double Pneumonia is greater than in civil practice.

Second. The cases are often sent in the active stages of the disease, and the symptoms are aggravated by the exposure and fatigue incident to the transfer.

Third. In many cases, the result has been decided before it is in the power of the physician to accomplish any good treatment.

Fourth. Many hospital patients have been debilitated and depressed by poverty, intemperance, severe labor and exposure.

Fifth. A larger proportion of cases supervening upon, or engrafted on fatal forms of disease, as Phthisis Pulmonalis and Bright's Disease of the Kidneys, occur in hospital practice.

Sixth. The types of pneumonia manifested in different seasons, and in different periods are more marked in hospital patients.

The preceding propositions will be illustrated to a certain extent by the following statistics and cases :

During a period of forty-five months, out of a grand total of two thousand three hundred and eighty cases treated by me, in the Charity Hospital of New Orleans, with a mortality of two hundred and thirty-five (9.83 per cent. or 1 death in 10.12 cases) of this number, diseases of the Respiratory System, including Phthisis Pulmonalis, numbered two hundred and ninety-nine, with sixty-three deaths (one death in 4.7 cases, or 27.5 per cent.); Phthisis Pulmonalis numbered one hundred and fifty cases, with forty-six deaths (one death in 3.2 cases); all other diseases of the Respiratory System, including Pneumonia, Pleuro-pneumonia, Pneumothorax, Hydro-pneumothorax, Bronchitis, acute and chronic, Asthma, Pleuritis and Emphysema numbered one hundred and forty-nine cases, with seventeen deaths (one death in 8.7 cases, or 11. per cent.).

The fatality accompanying pneumonia, as well as the type of the disease varied within wide limits during different periods: thus, during twenty-seven months (January, 1869 to April, 1870; October, 1870, to April, 1871; October, 1871, to April, 1872; out of a total of one thousand one hundred and eleven cases, with one hundred and six deaths, only nine cases of pneumonia were treated, all of which recovered and were discharged; during six months, October, 1872, to April, 1873, total cases of all diseases, two hundred and thirteen: deaths, thirty-nine from all causes; Pneumonia, twenty-two cases, nine deaths (and of this number thirteen were cases of pneumonia uncomplicated and confined to one lung, all of which recovered; two cases of pleuro-pneumonia supervening upon malarial fever, both of which terminated fatally, seven cases of double pneumonia, involving the greater portion of both lungs, all of which terminated fatally); during six months, October, 1873, to April, 1874, total cases, five hundred and thirteen; total deaths from all causes fifty-two; pneumonia, twenty cases; deaths, two (and of this number, eighteen cases were uncomplicated, all of which recovered, and two cases were complicated with phthisis, both of which terminated fatally); during six months, October, 1874, to April, 1875, total cases, four hundred and thirty-nine, total deaths thirty-seven; pneumonia, twenty-eight cases; five deaths (of this number, eighteen cases were uncomplicated, all of which recovered, five cases of pleuro-pneumonia, with one death, five case of double pneumonia, with four deaths).

It will be observed that even in Hospital practice in New Orleans, under the plan of treatment which I have pursued, recovery was the almost universal result in uncomplicated pneumonia, whilst in all the cases including those complicated with Phthisis and Malaria, (cases 79, deaths 16), the mortality was one death in 4.9 cases, or 20 per cent.

These results are placed in a still more favorable light, by the fact that in 801 cases of Pneumonia treated in the same Hospital at large, 1856–1860, 300 terminated fatally, one death in 2.6 cases, or 37.3 per cent.; 1866–1870, 409 cases, 184 deaths, one death in 2.3 cases, or 43.9 per cent.; 1871, 109 cases, 44 deaths, one death in 2.5 cases, or 40.3 per cent.; 1872, 135 cases, 59 deaths, one death in 2.3 cases, or 43.7 per cent.; 1873, 161 cases, 61 deaths, one death in 2.6 cases, or 37.9 per cent.; 1874, 130 cases, 43 deaths, one death in 3. cases or 33. per cent.

The following brief notes upon a portion of the cases treated in my wards, will illustrate the general results :

Case 713: J. C., age 50; native of Ireland; laborer; entered Ward 13, December 15th, 1874. Pneumonia of right lung: tubular breathing; crepitant and subcrepitant rales; dullness upon percussion; increase of vocal fremitus; bronchophony; rapid pulse and respiration; elevated temperature; flushed cheeks; tongue coated with brown fur; rusty colored sputa. The bowels were opened by a mercurial, and four grains of a mixture of equal parts of Quinine and Dover's Powder were administered every three hours; and ten drops of the Tincture of Yellow Jessamine Gelseminum, every six hours. Turpentine stupes were applied over the region of the inflamed lung. Milk Punch and Beef Tea were administered at regular intervals. In the course of nine days, the chlorides reappeared in the urine and the febrile excitement subsided, and convalescence was established. The patient was discharged, capable of performing his usual manual labors, on the 15th of January, one month after his entrance. As many of the patients entering the Charity Hospital of New Orleans, are without homes or means of support, beyond their daily labors, it has been my custom to retain the patients in the wards, until capable of performing such labors as are necessary to their daily support. The length of time, therefore, which the patients remained in the hospital, is not a just criterion by which to judge, of the rapidity of convalescence in disease.

Case 714: P. McD., age 35; native of Ireland; sailor; Pneumonia of right lung. Entered Ward 29, December 26th, 1874. Treatment as in preceding case; recovery rapid and complete; discharged January 5th, 1875.

Case 715: E. M., age 31; native of France; clerk; entered Ward 30, December 28th, 1874. Pneumonia of left lung. Treatment as in case 713; recovered; discharged January 23d, 1875.

Case 716: D. F., age 24; native of New Orleans; gardener; entered Ward 29, January 3d, 1875. Pneumonia supervening upon, and complicated with Malarial, fever. Entered on the 4th day of the Pneumonic inflammation. Quinine and Dover's Powders were freely used, and both the Pneumonic inflammation and Malarial fever were arrested, and the patient was discharged January 15th, 1875.

Case 717: W. C., age 38; native of Ireland; laborer; entered Ward 29, January 5th, 1875. Pneumonia of right lung complicated with Intermittent fever. Treatment as in preceding case; recovered; discharged January 18th.

Case 718: B. B., native of France; age 44; baker; entered Ward 29, January 8th, 1875. Pneumonia of right lung; recovered; discharged January 16th.

Case 719: H. R., native of China; age 23; laborer; entered Ward 30, January 11th, 1875. Pneumonia and Intermittent fever. Treatment as in case 713; recovered; discharged January 18th.

Case 720: J. K., age 19; native of New Orleans; laborer; entered Ward 13, January 17th, 1875. Pneumonia, lower lobes, both lungs; recovered; discharged February 10th, 1875.

Case 721: O. A., age 20; native of Austria; laborer; walked all the way on foot from New York. Entered Ward 29, January 19th, 1875. Pneumonia of left lung, accompanied with intense jaundice. High temperature, ranging from 103° to 105° F. Sputa of a golden color; sweat of a golden color; saliva in mouth golden colored; urine high colored and loaded with bile. Bowels were kept open by mercurials; Turpentine stupes were applied over region of diseased lung, and Quinine freely administered. Recovered; discharged January 27th, 1875.

Case 722: J. O'B., age 39; native of Ireland; brakesman; height, six feet, six inches; entered Ward 29, January 20th, 1875, on 4th day of disease. Pneumonia of both lungs complicated with Pleuritis. Treatment as in case 713. Pneumonic inflammation arrested; progress satisfactory; recovery; discharged February 5th, 1875.

Case 723: J. B., age 48; native of Ireland; laborer; entered Ward 30, January 25th, 1875. Pneumonia; recovered; discharged March 12th, 1875.

Case 724: M. McM., age 40; Ireland; carpenter. Ward 29, January 26th. Pneumonia and Intermittent Fever; recovered; discharged February 8th.

Case 725: H. R., age 40; native of Ireland, laborer. Ward 29, February 4th. Pneumonia. Treatment as in case 713. Recovered; discharged March 3d, 1875.

Case 726: J. C., age 29; native of Ireland; laborer; entered Ward 29, February 25th. Pneumonia; recovered; discharged March 18th, 1875.

Case 727: H. B., age 23; native of Germany; baker; Ward 30, February 27th, 1875. Pneumonia supervening upon and complicated with Remittent Malarial fever. Patient had high fever, and delirium, and great prostration for five days. Treatment consisting chiefly of Quinine and Dover's Powder, and Tincture Yellow Jessamine. Recovered; discharged March 1875.

Case 728: J. H., age 57; native of Ohio; laborer; Ward 30, March 1st, 1875. Pneumonia. Recovered; discharged March 13th.

Case 729: J. F. C., age 48; native of France; painter; Ward 30, October 13th, 1874. Double Pleuro-Pneumonia. Had been sick six days, before entering the hospital. Dullness upon percussion over both lungs, especially over lower lobes, where there was tubular breathing, and absence of respiratory murmur; Pleuritic effusion upon right side. Intense pain upon right side. Rapid pulse and respiration; great prostration; cheeks much congested; lips purple; tongue dry and coated with brown fur, and red at tip and edges; delirium. Prognosis unfavorable. Died October 16th, three days after entering the hospital.

Case 730: J. D., age 39; native of Ireland; laborer; Ward 29, December 23d. Double Pneumonia with bloody expectoration. Dullness upon percussion, absence of respiratory murmur, and tubular breathing, over lower lobes of both lungs; sputa consists of almost pure blood. High fever, flushed face, rapid respiration; congested lips and extremities; delirium. Prognosis unfavorable. Expectoration ceased entirely on the 24th; patient died December 25th, 1873, on third day after entering the hospital.

Case 731: P. H. K., age 33; native of New York; laborer; Ward 30, January 5th, 1875. Had been sick four days. Double Pneumonia and Pleuritis. High temperature, rapid pulse and respiration; furred tongue; wild delirium. Lips and cheeks congested and presenting a purple appearance. Intense pain over inflamed portions of both lungs. Chlorides absent from urine. Little or no expectoration. Died January 10th.

Case 732: G. A., age 38; native of Maryland; sailor; Ward 13, January 17th, 1875. Had been sick four days before entering. Double Pleuro-Pneumonia. High temperature; rapid respiration; great prostration; congested purple lips and cheeks; delirium. Under the use of Quinine, Dover's Powder, and Tincture of Yellow Jessamine, and together with nutritious diet and alcoholic stiumlants, this apparently hopeless case recovered, and was discharged February 18th.

Case 733: J. S., age 40; native of England; sailor; Ward 29, January 24th, 1875. Patient had been sick six days before entrance into hospital. High fever; great prostration; severe pain in right side; profuse expectoration of sero-purent matter. Auscultation and percussion, revealed, in addition to pneumonic solidification of lungs, the existence of an abscess in right lung, resulting from the destruction of the pulmonary tissue by the pneumonic inflammation. Died February 13th, 1875.

Post-mortem Examination.—Inferior lobes and posterior portions of both lungs in a state of grey hepatization. Left pleuritic cavity contained fluid, and coagulable lymph with adhesions. Abscess of right lung. Liver enlarged and cirrhosed. Kidneys normal. Urine contained no albumen.

Case 734: R. W., age 27; native of Germany; clerk; Ward 30, February 11th, 1875. High fever, rapid pulse; pneumonic sputa; dullness upon percussion and bronchial breathing, over lower lobes of both lungs. Under the action of Quinine and Dover's Powder, and Tincture of Yellow Jessamine, together with alcoholic stimulants and nutritious diet, pneumonic inflammation arrested. This patient was suffering with secondary syphilis. Recovered. Discharged February 24th.

Case 735: P. H. G., age 45; native of Ireland; laborer; W. 13, February 22d. Had been sick six days. Dullness upon percussion with bronchial breathing over upper lobes of both lungs. Double Pneumonia. Little or no expectoration. High fever; rapid pulse, rapid respiration; great congestion of capillaries of lips, cheeks and extremities. Delirium. Feb. 24th, temperature of axilla, evening, 105° F.; 25th, morning, temperature, 104°.5; evening, 106°; 26th, morning, temperature, 107°; violent delirium. Face and extremities present a dusky purplish appearance. Died February 26th. Post-mortem.—Upper portions of both lungs solidified, and passing into stage of gray hepatization.

Case 736: P. C., age 30; native of Ireland; hack driver; W. 13, February 27th, 1875. Had been sick 8 days.

Dullness upon percussion, with bronchial breathing over large tracts of both lungs. High fever, rapid pulse, rapid respiration, little or no expectoration; chlorides absent from urine. No albumen in urine. Blue lips, and dusky, congested countenance and extremities. Feb. 28th, temperature of axilla, morning, 103°.5; evening, 104°. March 1st, morning 102°.5; evening, 104°. Wild delirium, passing into coma. Died March 2d, 1875.

Post-mortem.—Portions of both lungs in stage of gray hepatization. Both patients (Cases 735 and 736), entered in the last stages, and treatment appeared to exert no appreciable effects upon the progress of the disease.

Case 737: H. K., age 23; native of England; sailor. Entered ward 13, Feb. 10th, 187 Pleuro-Pneumonia of both lungs, and Pericarditis engrafted on Phthisis Pulmonalis. Entered with elevated temperature, rapid pulse, rapid respiration; oppressed respiration, blue lips and hands. Dullness and absence of respiratory sounds, with exception of tubular breathing over left lung, and over upper lobe of right lung; friction sound over region of heart; no expectoration; chlorides absent from urine.

Sounds of heart indistinct. The sufferings of this patient were great on account of the pleuritic pain, oppression of breathing, and oppressed action of the heart. February 12th, evening, temperature, 105; 13th, morning, 104°; evening, 105°; 14th, morning, 103°; evening, 104°.8; 15th, morning, 101°.4; evening, 104°; morning, pulse, 112; respiration, 31; 16th, morning, pulse 122; respiration 35; temperature, 103°.3; evening, 104°; 17th, morning, pulse, 120; respiration, 42; temperature, 104°; evening, 105°; 18th, morning, pulse, 110; respiration, 42; temperature, 103.

Died February 18th, 1873.

Post-mortem examination revealed tubercular deposits in both lungs; solidification, and softening, and gray hepatization of entire left lung, and of upper lobe of right lung; golden colored, coagulable lymph over surface of pleura and pericardium. Bronchial tubes filled with sero-purulent matter. Cavity in right lung.

Case 738: A. G., native of Cuba; age 23; sailor. Ward 13, Feb. 4th, 1873. Pleuro-Pneumonia of both lungs, engrafted on Phthisis Pulmonalis. Entered with high fever, rapid pulse, rapid respiration, great prostration, delirium, dullness over both lungs, with crepitant, sub-crepitant, mucous, sibilant and sonorous rales. Expectoration quite profuse, and also purulent, and partially gelatinous, and rusty colored. Flatness upon percussion, most marked in inferior clavicular region of both lungs. Died Feb. 16th, 1873.

Post-mortem Examination.—Miliary tubercles scattered through both lungs. Portions of both lungs were in a state of pneumonic inflammation and hepatization. Coagulable lymph upon pleura.

Large cavity in superior lobe of left lung. Pneumonic inflammation confined chiefly to left lung.

In this case, (738), the patient had, eight months before his death, suffered with a sudden and profuse hæmorrhage from the lungs. At this time entered the Charity Hospital and after remaining three weeks, was discharged in an apparently improved condition.

In the early part of January, the patient was much exposed to wet and cold, on board a small vessel running between New Orleans and Havana. Was suddenly attacked with severe pain in left side, difficulty of breathing, increase of cough and high fever. When the patient entered the Charity Hospital, on the 4th of February, he was very restless, cried out: complained of intense pain in both sides; distressed, haggard expression; high fever, rapid pulse, rapid respiration: cavernous respiration in superior mammary region of left lung; friction sounds of pleuritis; crepitant, sub-crepitant, mucous, sibilant and sonorous rales. Right lung dull upon percussion, with crepitant, sub-crepitant, sibilant, sonorous and mucous rales. The temperature exhibited marked diurnal oscillations, as manifested by the following record:

July 5th, morning, temperature, 103°: pulse, 90: respiration, 36; evening, 105°. 6th, morning, temperature, 101°.8: pulse, 88; respiration, 34; evening, temperature, 105°.5. 7th, morning, temperature, 100°.6: pulse, 80; respiration, 34; evening, 105°.8. 8th, morning, temperature, 101°.4; pulse, 90; respiration, 35; evening, 105°.4. 9th, morning, temperature, 102°; pulse, 88; respiration, 33; evening, temperature, 106°. 10th, morning, temperature, 101°; pulse, 88: respiration, 33; evening, temperature, 106.°7. 11th, morning, temperature, 106°; pulse, 104; respiration, 42; evening, temperature, 105°.9; pulse, 140; respiration, 50. 12th, morning, temperature, 104°; pulse, 130; respiration, 44; evening, temperature, 105°.1; pulse, 136; respiration, 50. 13th, morning, temperature, 101°.3; pulse, 140; respiration, 50; evening, temperature, 105°.6; pulse, 160; respiration, 50. 14th, morning, temperature, 102°; pulse, 130; respiration, 44; evening, temperature, 103°: pulse, 140; respiration, 50. 15th, morning, temperature, 102°; pulse, 144; respiration, 42; evening, temperature, 104°; pulse, 150; respiration, 44. 16th, morning, temperature, 101°.8; pulse, 112; respiration, 42. Died July 16th, at 2 P. M. Marked decline of temperature before death.

On the night of the 10th inst, the patient was suffering such intense pain from the pleuritic inflammation, that he called for a knife, with the avowed intention of committing suicide.

This case illustrates, in a clear manner, the marked elevation of temperature which the supervention of pneumonia and pleuritic inflammation is capable of inducing in patients suffering with phthisis pulmonalis.

As a general rule, the temperature is elevated above the normal standard in phthisis, but this elevation is less than that characteristic of pneumonia.

Case 739: P. H., age, 38; native of New Orleans: ward 13. November 23d, 1872; pleuro-pneumonia of both lungs, engrafted on malarial fever. Both lungs involved; right lung entirely solidified; flatness on percussion, and absence of respiratory murmur over right lung, and superior portion of left lung; violent delirium; rapid, feeble pulse; congestion of capillaries. lips and extremities purple; no trace of chlorides in urine; no albumen; urine high-colored and loaded with urea and uric acid; sputa very small in amount and almost entirely absent. I was compelled to use opium with great caution in this case, on account of the great embarrassment of respiration and the pain caused by the pleuritic inflammation. Complete solidification of the inflamed portions of the lungs had occurred before the patient entered the Charity Hospital.

Post-mortem Examination:—Pleura of both lungs inflamed and coated with fibrinous effusion. Gray hepatization of right lung and of superior portion of left lung.

Case 740: J. P——, age 42; native of Ireland: ward 29, February, 1873; double pneumonia. Disease caused by exposure to cold, damp and wet on banks of the Mississippi. Entered with great oppression and capillary congestion: lips blue; dullness on percussion over right lung; tubular breathing, and absence of vesicular murmur in lower lobe of left lung. Temperature of axilla, at time of entrance, February 14th, M., 103°. 2 F. 16th, pulse, 140; respiration, 28; temperature, morning, 103°. 17th, pulse, 130; respiration, 22; temperature, 103°. 5. 18th, morning, pulse, 132; respiration, 22; temperature, 104° F. Died July 18th.

Case 741: A. McC——, age 54; Scotland: laborer; entered Charity Hospital, March 28th, 1873. Pleuro-pneumonia of both lungs supervening on malarial fever. Disease caused by exposure to wet and damp in swamps of Mississippi river, and abuse of alcoholic stimulants

Entered my ward in *extremis:* rapid, feeble pulse; labored, embarrassed respiration; unhealthy malarial hue; congestion of capillaries of face and extremities; lips and extremities congested, and of a mottled, purple appearance; dullness and flatness upon percussion over greater portion of both lungs; great pain during respiration, cries out with every breath; died March 31st, fifty hours after entering the Charity Hospital.

Post-mortem examination, confirmed the diagnosis, viz: pleuro-pneumonia of both lungs. The liver and spleen presented the characteristic alterations of malarial fever.

Case 742:—D. M——, age 40. Native of Ireland. Entered Charity Hospital, January 28th. Pleuro-pneumonia of both lungs, caused by exposure to cold and wet in swamps of Mississippi river. This patient entered in extremis; complete flatness upon percussion over entire right lung; entire absence of respiratory murmur, and presence of tubular breathing over position of large bronchial tubes. Lower lobe of left lung flat on percussion. Great difficulty of respiration; high fever; rapid pulse; capillary congestion; surface of extremities mottled; lips blue; veins distended with black blood.

January 28th.—Evening, temperature, 104°.6; pulse, 112; respiration, 64. 29th, morning temperature, 104°.5; pulse, 112; respiration, 52; evening, temperature, 104°.8; pulse, 112; respiration, 60. 30th, morning, temperature, 104°.2; pulse, 120; respiration, 48; evening, temperature, 105°; pulse, 120; respiration, 60. 31st, morning, temperature, 104°.5; pulse, 116; respiration, 60; evening, temperature, 104°; pulse, 128; respiration, 56. Died February 1st, morning.

Died seventy hours after entering the hospital, February 1st, 1873.

Post-mortem examination—Diagnosis confirmed:—Gray hepatization of entire right lung, with effusion of yellow, golden colored lymph on pleura. Hepatization of lower lobe of left lung, with effusion of coagulable lymph upon pleura. Liver, slate color on exterior, with pigment granules. Spleen enlarged and softened.

Case 743: C. P——, age 25; native of England. Entered Charity Hospital, February 10th, 1873. Pleuro-pneumonia engrafted on malarial fever and chronic dysentery. Disease referred to exposure in swamps of Louisiana, and to cold, wet and bad diet. Patient had suffered with malarial fever and chronic dysentery for some time, before entering the hospital. Flatness over entire left lung, with absence of respiratory murmur, and presence of tubular breathing over region of large bronchial tubes. No expectoration. Frequent action of bowels, of a dysenteric nature, and attended with great pain and straining.

Post-mortem examination revealed gray hepatization of entire left lung; congestion of right lung; slate colored liver, with pigment deposit; enlarged spleen, and congestion and ulceration of large intestines.

Case 744: S. M. C, age 21, native of Virginia; entered Charity Hospital, February 19th, 1873. Complained of severe pain in left lung, with oppression of breathing. Auscultation and percussion, revealed dullness upon percussion with hurried breathing over left lung, tubular breathing, and absence of respiratory murmur. Dullness and flatness most marked over left lung. Violent delirium. It was necessary to confine the patient in bed. Quinine, Dover's Powders, Alcoholic Stimulants and blisters to side, produced no visible beneficial effects. 19th, temperature of axilla, morning, 100°.5. 20th morning, 102°.5; evening, 103°.5. 21st, morning, 103°; evening, 103°. 22d morning, 102°; evening, 104°; intellect wanders. 23d morning, 102°.5; evening, 102. 24th morning, 103.5; evening. 103°.; pain in both sides, flatness upon percussion over lower lobes of both lungs. 25th morning, 103°.; evening, 103°.5. 26th morning, 104°.; evening, 105°.5; auscultation and percussion reveals that the pneumonic inflammation is extending in both lungs. 27th, morning, pulse, 128; respiration, 24; temperature, 103°.5; evening, 104°.5. 28th, morning, temperature 105°.; pulse, 120; respiration, 24; evening, pulse 140; respiration, 38; temperature, 104°.5. March 1st, pulse, 140; respiration, 45; temperature, 104°.5. Died March 1st, 1873.

Post-mortem.—Right lung solidified, with the exception of about one-fourth of the upper lobe. Left lung solidified, with the exception of a small portion of the border of the upper lobe. Portions of both lungs in a state of gray hepatization; soft, readily broken down by the finger, and filled with purulent matter. Liver enlarged.

In this case, the violent delirium appeared to be due to the imperfect oxidation and purification of the blood by the respiratory process. Throughout the active stages of the disease and up to the fatal termination, the chlorides were absent from the urine, as well as also albumen. This excretion was of a deep red color, and loaded with urea, uric acid, biliary acids and the coloring matters of the bile.

Case 745: J. K., age 43; native of Ireland; laborer. Entered Charity Hospital, March 8th, 1873; high fever; delirium; lips and hands purple and congested; great oppression of respiration; flatness upon percussion, over entire left lung; absence of vesicular murmur; tubular respiration over region of large bronchial tubes; little or no play in the lungs during respiration. Dullness over lower lobe of right lung. Great congestion of the capillaries of the extremities, and the veins appear to be filled with black blood. No expectoration. Bled at nose. Died within twenty-four hours after entering my ward, (March 9th.)

Post-mortem Examination revealed gray hepatization of entire left lung, effusion of coagulable lymph on surface of pleura, solidification of lower lobe of right lung. The solidification of the left lung, and of the lower lobe of the right lung was complete.

The absence of expectoration in this and other cases of pneumonia, which occurred during the winter and spring of 1873, appear to be referable to the severity of the type of the disease and to the rapidity with which large practs of the pulmonary tissue was solidified.

Case 746: P. H., age 38. Native of New Orleans. Entered C. H., Nov. 23d, 1872. Has been exposed to malaria, wet and cold, whilst working in swamps of Mississippi River, and has suffered with Malarial Fever. Both lungs involved in the pneumonic inflammation. Right lung solidified. Flatness upon percussion and absence of respiratory murmur, over right lung and superior portion of left lung. Violent delirium; rapid, feeble pulse; congestion of capillaries of face and extremities which present a purple, mottled appearance. Great pain and difficulty in respiration. Diagnosis: pleuro-pneumonia of both lungs, engrafted on Malarial Fever. No trace of chlorine or albumen in urine. Urine scant, high colored and concentrated; loaded with urea, uric acid and bile.

When Nitric Acid is added to the urine, a heavy deposit of uric acid falls, but heat dissolves this deposit and renders the urine clear. November 23d, morning, pulse 102; temperature 104°.4 F.; evening, pulse 144; temperature 104°.4; 24th, morning, pulse 120; temperature 103°; evening, temperature 105°.3; 25th, morning, temperature 103°; evening, 105°.6; 26th, morning, pulse 119; temperature 104°; evening, pulse 128; temperature 105°.3; 27th, morning, pulse 126; respiration 18; temperature 104°.5; evening, pulse 126; respiration 24; temperature 103°.5; 28th, morning, pulse 114; respiration 24; temperature 103°; evening, pulse 108; respiration 30; temperature 104°.5; 29th, morning, pulse 114; respiration 60; temperature 102°.5; evening, pulse 132; respiration 60; temperature 104°. Died November 30th, 1872; sputa very scant, almost entirely absent.

Post-mortem.—Pleura of both lungs coated with yellow plastic lymph. Gray hepatization of right lung and superior portion of left lung. Liver and spleen presented evidences of the preceding action of the malarial poison.

Case 747: T. S., age 20, native of Boston, Mass.; entered C. H. 13th February, with Pneumonia and Dysentery. Dullness upon percussion of left lung; discharges from bowels mucus and blood. Under Quinine, Dover's Powder and Sub. Nit. of Bismuth, the patient recovered. The temperature during the active stages of the Pneumonia, ranged from 102° to 104°.8 F.

Case 748: Augustus J., age 34, native of Sweden. Admitted January 20th, 1873. Was seized with pain in side and difficulty of breathing, and fever, two days before entrance into hospital. Had suffered with Malarial Fever. The following observations were made upon the pulse and temperature: January 22d, morning, pulse 108; temperature 104°.6; evening, pulse 104; temperature 103°.9; 23d, morning, pulse 84; temperature 100°.5; evening, pulse 108; temperature 104°.2; 24th, morning, pulse 100; temperature 99°; evening, pulse 104; temperature 104°; 25th, morning, pulse 80; temperature 99°; evening, pulse 104; temperature 104°; 26th, morning, pulse 98; temperature 101; evening, pulse 100; temperature 102°; 27th, morning, pulse 98; temperature 102°; evening, pulse 82; temperature 101°; 28th, morning, pulse 80; temperature 101°.6; evening, pulse 88; temperature 103°; 29th, morning, pulse 72; temperature 101°; evening, pulse 80; temperature 102°; 30th, morning, pulse 76; temperature 99°.3; evening, pulse 76; temperature 101°.8. Daily records of the temperature were made in this case, up to the date of his discharge, March 3d, 1872. Recovery attributed chiefly to Quinine, Dover's Powder and nutritious diet.

Case 749: J. H., age 45, native of Canada. Entered ward 13, January 9th, 1873. Had been suffering with symptoms of Phthisis Pulmonalis, viz: cough, expectoration and fever, for some time before the present attack. After exposure to wet and cold on the Mississippi River, was seized with pain in the side, oppression of breathing and high fever. Patient determined to come South to New Orleans, on account of his health (cough, fever and night sweats). Whilst passing on steamboat, from Cairo to Memphis, was exposed to cold and wet, and on the 26th of December, 1872, was seized with pain in right side, attended with incessant cough, profuse, purulent and pneumonic expectoration, great oppression of breathing, rapid pulse and elevated temperature.

January 13th, 1873. Mucous, sonorous, crepitant and sub-crepitant râles heard over both lungs. Expectoration profuse and purulent. Morning, temperature 100°; evening, 105°. January 14th. Dullness upon percussion over upper portion of right lung; greatest above fifth rib, in which position the dullness is more correctly termed absolute flatness. Left lung more resonant, and mucous and sonorous râles heard loudest in infra-clavicular region. No albumen in urine, chlorides also absent.

Temperature.—Morning 99°, evening 103; 15th, morning 101, evening 105; 16th, morning 99, evening 106; 17th, morning 100, evening 105.5; 18th, morning 99, evening 106; 19th, morning 100, evening 105.8; 20th, morning 99.4, evening 106.1; 21st, morning 99, evening 103; 22d, morning 99.4, evening 105; 23d, morning 102, evening 107.8; 24th, morning 105.4 evening 105; 25th, morning 100, evening 105; 26th, morning 98.8, evening 107.3; 27th,

morning 97.5, evening 107.2; 28th, morning 100, evening 107.3; 29th, morning 99.5 F. Swelling of feet observed January 21st. January 26th, had severe chill in the afternoon, lasting three hours, attended with great elevation of temperature in the stage of reaction, and with profuse sweating. Another chill, afternoon of 27th. Large dose of Quinine, in all about 40 grains, were administered each day, on the 27th and 28th. No beneficial effects whatever were observed, and the temperature reached 107, in the evening of both days. Died January 29th, 6 P. M. Temperature fell before death.

This case, 749, furnishes another striking illustration of the marked elevation of temperature induced by the supervention of Pneumonia in Phthisis Pulmonalis.

Thus, the axillary temperature reached, in the evening of the 23d of January, nearly 108° F., or, more exactly, 107°.8 F. It is probable that the temperature of the central organs was at least 110° F. I have already recorded two cases of Pneumonia, uncomplicated by Phthisis, in which the high degree of 109° F. was manifested in the axilla. Both these cases recovered, thus furnishing evidence that such high degrees of temperature are not necessarily fatal in Pneumonia.

The chills and profuse sweats which characterized the case (749), appeared to be due to the absorption of the products of inflammation.

Sudden elevations of temperature in Phthisis may also be excited by inflammation of the brain and its meninges, as in the following case.

Case 750.—J. M., age 15, native of Austria. Entered ward 15, Charity Hospital, Dec. 24, 1872. Pale, anæmic, emaciated; feeble, irritable pulse; flatness in infra-clavicular region of both lungs. Cavity with cavernous respiration in right lung. Marked daily oscillations of temperature. January 3d, pulse feeble, copious discharges from bowels. It was necessary to control the bowels by astringents and opiates. On the 21st and 22d of January this patient suffered with violent pain in the head and delirium. During the delirium, although the patient is able to speak only a few words of "broken" English, he repeats accurately my prescriptions and directions to the nurse, and remarks to the patients and medical students. On the 20th, the day preceding the cerebral disturbance, the maximum temperature was 102°4. F., whilst on the 21st, during the delirium, the thermometer in the axilla indicated 106°.2 F., or an abrupt rise of 3°.8. Under the free use of alcoholic stimulants, in combination with milk and nutritious diet, the violent delirium subsided, and on the 25th the maximum axillary temperature was 103°.2.

On the 2d of February the patient again complained of pain in the head, the pulse became fuller and stronger, the patient became delirious, and the increase of temperature was marked, and the thermometer in the axilla reached 105°.4. With the subsidence and disappearance of the delirium, the temperature again declined.

The pain in the head and delirium returned at intervals, Feb. 7th, 8th, 9th, 10th, 14th, 15th, 16th, 22d, 23d, and March 8th, and at such times the evening temperature ran high.

The following observations will illustrate the sudden oscillations of temperature in this case:

January 11th. *Temperature.*—Morning 102, evening 103; 12th, morning 101.5, evening 103.2; 13th, morning 102, evening 103.6; 14th, morning 101.8, evening 103; 15th, morning 101.8, evening 103.5; 16th, morning 101.5, evening 104; 17th, morning 101.5, evening 103; 18th, morning 102, evening 103; 19th, morning 100.2, evening 102; 20th, morning 100.2, evening 102.5; 21st, morning 100.3, evening 106.2; 22d, morning 99, evening 104.2; 23d, morning 101, evening 104; 24th, morning 100.6, evening 103.8; 25th, morning 100.8, evening 103.1; 26th, morning 101, evening 103.1; 27th, morning 101, evening 103.5; 28th, morning 102, evening 102.6; 29th, morning 100, evening 103.6; 30th, morning 99.8, evening 103; 31st, morning 100.2, evening 103. February 1st, morning 105.5, evening 102; 2d, morning 100, evening 105.4; 3d, morning 99.2, evening 103; 4th, morning 99 1, evening 104; 5th, morning 100, evening 103; 6th, morning 101.2, evening 102.5; 7th, morning 101, evening 104; 8th, morning 101, evening 104.6; 9th, morning 101.5, evening 102; 10th, morning 101, evening 104.6; 11th, morning 101.2, evening 103.8; 12th, morning 100, evening 103.6; 14th, morning 100, evening 104.5; 16th, morning 102.2, evening, 105; 16th, morning 101.2, evening 104.8; 17th, morning 100, evening 103; 21st, morning 101.6, evening 102; 22d, morning 101, evening 105; 23d, morning 101, exening 104.6; 24th, morning 101, evening 103.8; 25th, morning 103, evening 104.8; 26th, morning 100, evening 103.8. March 2d, morning 102.5, evening 103.8; 3d. morning 102.5, evening 103.7; 4th, morning 102.5, evening 104.6; 5th, morning 102.8, evening 104.8; 6th, morning 102.2, evening 103.5; 7th, morning 101, evening 104; 8th, morning 90, evening 105; 9th, morning 102, evening 102.8; 10th, morning 101, evening 103.4 11th, morning 101, evening 103.8.

Notwithstanding the gravity of the symptoms in this case, and the elevated temperature, the strength gradually improved and the weight increased, under the continuous administration of the Hypophosphites of Lime, Iron, Soda and Potassa, Cod-Liver Oil, Alcoholic Stimulants and nutritious diet.

Case 751.—N. W., age 34; native of Denmark; sailor, clerk. Admitted into the Charity

Hospital January 13th, 1873. Suffered with cough attended with fever, December, 1871. At this time suffered with hæmoptysis, which induced great prostration. Has had no recurrence of the hæmoptysis, but has been under the care of physicians, and has pursued his ordinary avocations up to the time of his entrance into the Charity Hospital, February 1st. Patient emaciated, cheeks flush; eyes bright; skin hot; pulse rapid; suffers with harsh, distressing cough. Voice greatly altered from its natural tone; harsh and sepulchral. Patient says that he has never suffered with syphilis. Marked depression in super-clavicular, and also in infra-clavicular regions, over apices of both lungs. Dullness not amounting to flatness, over apices of both lungs; more marked over the left; puerile respiration over middle and lower portions of both lungs. Rude broncho-vesicular respiration over portion of upper lobe of right lung.

Sub-crepitant rales over inferior border of left scapula. Decubitus preferable on left side. This then is a case of Phthisis Pulmonalis, with circumscribed, interstitial Pneumonia. This patient was attacked at various times with severe and incessant cough, high fever, attended with increase in the purulent mucus. At such times the sputa became much more tenacious. These exacerbations, were always attended with increased temperature. The following observations will illustrate the daily oscillations of temperature:

January 18th, morning 102, evening 104.4; 19th, morning 103, evening 105; 20th, morning 102, evening 105; 21st, morning 103.2, evening 102; 22d, morning 101, evening 102; 23d morning 102, evening 104; 24th, morning 101.5, evening 105; 25th, morning 102.2, evening 105; 26th, morning 101.2, evening 103 6; 27th, morning 102, evening 103.6; 28th, morning 102, evening 104; 29th, morning 101.4, evening 104.4; 30th, morning 100, evening 103.

The observations on the temperature of this patient were continued for near 100 days, and during this time the maximum morning temperature was 102, the minimum 98.5; the maximum evening temperature 105 F., and the minimum 101.5 F.

I attributed the sudden elevations of temperature in this case to pneumonic inflammation of circumscribed portions of the lungs.

Under the continuous use of Cod-liver Oil, Hypophosphites, Alcoholic Stimulants and nutritious diet, the improvement of this patient was slow, but marked, and upon the 1st of March, he was stronger and in fuller flesh than upon his entrance.

Case 752: J. A., age 26, native of New Orleans; barber. Admitted, Charity Hospital, December 19th, 1872. Tubercular deposits and cavity in right lung; Phthisis; increased respiration; cavernous respiration; bronchophony; crepitant and mucous rales.

The temperature was recorded daily during a period of 30 days. The maximum morning temperature 102.6, minimum 100; maximum evening temperature 104.5, minimum 99. As a general rule, the temperature in this case of Phthisis did not rise above 102.6, during the 24 hours. This patient improved under the treatment with Cod-Liver Oil and hypophosphites, and bitter tonics, and with the increase of flesh there was also a diminution of temperature, and the variations between the morning and evening temperatures were less marked.

Case 753: A. K., age 32; native of Sweden. Entered Charity Hospital, September 21st, 1872. Says that his father died with Syphilis. Had suffered with cough and fever several months before entering the hospital. Dullness on percussion, and tubular respiration, and mucous rales, in sub-scapular region of both lungs. Profuse purulent expectoration.

In this case during a period of 120 days in which observations were made upon the temperature, the maximum morning axillary temperature, was 101, minimum 100; maximum evening temperature 102.8, minimum 101. The mean evening temperature was 102.2, and the mean morning temperature 100.5.

The pulse in the morning ranged from 72 to 82; in the evening from 81 to 92; respiration, morning 30 to 36, evening 36 to 40.

Under the continuous use of Cod-Liver Oil, Syrup of Hypophosphites, and Tincture of Cinchona, with nutritious diet, this patient slowly improved, and was discharged at his own request, February 3d, 1873, a favorable opportunity having offered for his return to his native country.

Case 754: J. W., age 32; native of Ireland. Entered Charity Hospital, September 2d, 1872. Dullness on percussion, with tubular breathing, bronchophony and mucous rales, in infra-clavicular region of both lungs. The existence of Phthisis also manifested by the persistent elevation of temperature. The morning axillary temperature ranged between 99 and 100.2; and the evening temperature between 101.5 and 103, during a period of 20 days. Improved under treatment.

Case 755: N. B., age 33; native of Ireland; car driver. Entered ward 13, December 1st, 1873. Has led a life of exposure, and had hæmorrhage twice from his lungs. During the past three months has suffered with cough and fever, and has lost considerable flesh. Says that both his parents lived to old age, and died of acute diseases. Apex beat of heart in normal position, but the first sound is accompanied by a murmur, propagated along the course of the aorta. The pulsations of the arch of the aorta are distinctly visible in the supra-sternal region, which is much fuller than normal. When the hand is placed on the tumor in the notch of the sternum, the enlarged dilated arch of the aorta can be distinctly felt, and a strong impulse is communicated to the fingers, synchronous with the contraction of the ventricles. Patient suffers with night sweats, and expectorates purulent matter. Infra-clavicular regions of both lungs, flat and dull upon percussion, with tubular breathing and mucous rales. Diagnosis; dilatation of arch of aorta and phthisis pulmonalis.

During a period of 90 days in which observations were made on the temperature, the morning axillary temperature ranged between 99.5 and 101; and the evening temperature between 101 and 103 F. This patient continued under treatment 18 months, with slight changes. There was no apparent increase in the size of the aortic dilatation or aneurism; which result appeared to be due mainly to the state of almost absolute rest.

Cod-liver Oil, Hypophosphates, Tincture of Cinchona, gentle expectorants and sedatives, with nutritious diet, appeared to moderate the rapidity of the march of the disease, but the patient was gradually reduced in flesh and strength; an exhausting, purulent expectoration, and night sweats, with harrassing cough, continued throughout the disease. Uncontrollable diarrhœa appeared during the last forty days of existence, and hastened the final issue.

CASE 756: T. C., age 37; native of Indiana. Entered ward 13, December 2d, 1873. Disease, Phthisis, complicated with Hydro-Pneumo-Thorax of left lung. The Pneumo-Thorax appeared to have been the result of the softening and ulceration of a tuberculous mass upon the surface of the lungs. As far as could be estimated, by careful auscultation, percussion and succussion, about two quarts of liquid had been effused into the left pleural cavity. The heart was displaced and pushed over to the right of the central line of the sternum. Succussion gave a metalic, splashing sound. The fluid extended up to the lower border of the sixth rib, when the patient was in the standing or sitting position. Below the border of the sixth rib there was entire absence of all respiratory and vocal sounds; above the sixth rib there was marked amphoric respiration and metallic tinkling. There was tympanitic resonance, on percussion, from the summit of the affected side to the level of the fluid, and flatness below, the relation of the flatness and tympanitic resonance changing with the change in the position of the patient.

In this interesting case during 14 days in which records of the temperature were kept, the morning temperature ranged from 98.5 to 100°.8; evening temperature from 101 to 102°.5. Before death there was a marked decline of temperature.

CASE 757: Wm. G., age 22; W. 13, Dec. 29th, 1872. Phthisis Pulmonalis. In this case, the morning temperature ranged from 98 to 101°.5, and the evening temperature from 98.5 to 103° F., during a period of thirty days.

CASE 758: J. E. D., native of New York; gardener; age 25; ward 27. Has been suffering with cough, fever and night sweats for four months. Has had hæmorrhage from the lungs. Disease, Phthisis Pulmonalis. Entered Charity Hospital, October 6th, 1872. This patient has led a wild, reckless life, and has also suffered with syphilis. In this case, the temperature varied within wide limits, and such variations appeared to be connected with inflammatory action in circumscribed portions of the lungs.

I abstract the following observations from the record which I kept of the changes of the pulse, respiration and temperature, up to the date of the discharge of this patient, who felt himself sufficiently improved to attempt a journey to his relatives in New York. From letters received from this patient, I learned that he had reached home in safety, and continued to improve.

October 12th, morning, pulse 110, respiration 26, temperature 101.°5; evening, pulse 118, respiration 28, temperature 102°. 13th, morning, pulse 120, respiration 28, temperature 100.°5; evening, pulse 126, respiration 28, temperature 101.°7. 14th, morning, pulse 112, respiration 30, temperature 100.°5; evening, pulse 102, respiration 30, temperature 100.°8. 15th, morning, pulse 106, respiration 37, temperature 95.°7; evening, pulse 130, respiration 34, temperature 102.°6. 16th, morning, pulse 118, respiration 40, temperature 101.°5; evening, pulse 114, respiration 44, temperature 103°. 17th, morning, pulse 120, respiration 36, temperature 101.°2; evening, pulse 120, respiration 40, temperature 105.°2. 18th, pulse 120, respiration 38, temperature 102.°2. 20th, evening, pulse 136, respiration 38, temperature 105.°1. 22d, morning, pulse 120, respiration 44, temperature 100.°1; evening, temperature 103.°8.

CASE 759: A. Q. Age 19. Entered ward 13, January, 1872. From the history, it was evident that this patient had suffered with phthisis pulmonalis for several months before entering the Charity Hospital, and that from exposure to wet and cold the right lung had been affected with interstitial pneumonia. The pneumonic symptoms continued from the 21st to the 29th of January, and the maximum axillary temperature was 104°.8 F. On the 19th of February, symptoms of circumscribed interstitial pneumonia again appeared, and the maximum temperature was reached on the 22d, when the thermometer in the axilla reached 103°.8. The following extracts from the record, extending over sixty days, will illustrate these changes in the temperature of phthisis as influenced by the pnemonic inflammation:

January 22d; morning, *temperature—degrees*, 104.8, evening 105.5; 23d, morning 100.5, evening 104.2; 24th, morning 99, evening 104; 25th, morning 99, evening 104; 26th, morning

*TABLE Illustrating the Rate of Mortality in Pneumonia under **Different Modes of Treatment.** **Prepared from the Hospital and Field Reports of the Confederate States Army of America, and also from the published statistics of various European Hospitals and Armies.** By Joseph Jones, Surgeon in the Provisional Army of the Confederate States.*

NAME OF HOSPITALS AND PHYSICIANS.	LENGTH OF TIME.	SYSTEM OF TREATMENT.	No. of Cases of Pneumonia.	No. of Deaths from Pneumonia.	Per cent. of Deaths in Cases of Pneumonia.	One Death in — Cases of Pneumonia.
Confederate forces serving in S. Ca., Ga. and Fla.; mean strength 25,670; field reports	19 months—Jan. 1862–July, 1863		2,120	127	5.99	16.7
Confederate forces serving n S. C., Ga. and Fla.; hospital reports	19 months—Jan. 1862–July, 1863		1,862	370	19.8	5.03
Confederate forces serving on Gulf of Mexico; mean strength 6,752; field reports	19 months—Jan. 1862–July, 1863		1,163	151	12.9	7.7
Confederate Army of the West and Tennessee; mean strength 40,273; field reports	12 months—June, 1862–May, 1863		6,974	1,090	15.6	6.4
Confederate Army of the West and Tennessee; hospital reports	12 months		2,957	542	18.3	5.4
Empire Hospital, Atlanta, Ga	28 months—March, 1862–Oct. 1864		267	73	27.3	3.6
Medical College Hospital. Atlanta, Ga	29 months—Feb'ry, 1862–June, '64		343	122	35.5	2.8
Gate City Hospital, Atlanta, Ga	16 months—March, 1862–Nov. 1863		381	51	13.3	7.4
Institute Hospital, Atlanta, Ga	13 months—Sept. 1863–Sept. 1864		198	45	22.7	4.4
Fair Gronnd Hospital No. 1, Atlanta, Ga	24 months—Oct. 1862–Sept. 1894		322	114	35.4	2.8
Fair Ground Hospital No. 2, Atlanta, Ga	20 months—Feb. 1863–Sept. 1864		324	96	29.6	3.37
Polk Hospital, Rome, Atlanta, and Vineville, Ga	12 months—Oct. 1863–Sept. 1864		54	11	20.3	4.9
Roy Hospital, Atlanta, Ga	10 months—Jan. 1863–Jan. 1864		50	11	22.	4.5
Ocmulgee Hospital, Macon, Ga	9 months—Feb. 1854–Oct. 1864		50	6	12.	8.3
Stout Hospital, Macon, Ga	4 months—June 1864–Sept. 1864		10	3	30.	3.33
Blind School Hospital, Macon, Ga	9 months—Jan. 1864–Sept. 1864		37	6	16.2	6.1
Floyd House Hospital, Macon, Ga	30 months—Apr. 1862–Sept. 1864		205	47	22.9	4.3
Marine Hospital, Charleston, S. C	13 months—Jan. 1862–Feb. 1863		25	9	36.0	2.77
Citadel Square Hospital, Charleston, S. C.	10 months—Jan. 1862–Mar. 1863		67	8	11.9	8.37
Trapman Street Hospital, Charleston, S. C	16 months—Dec. 1861–Mar. 1864		50	4	8.00	12.5
General Hospital No. 1, Savannah, Ga	25 months—Dec. 1861–Jan. 1864		370	116	31.35	3.18
General Hospital No. 2, Savannah, Ga	June, 1862–Jan. 1864		108	25	23.14	4.32
Guyton Hospital, near Savannah, Ga	May, 1862–Jan. 1864		78	7	8.98	11.14
General Hospital, Staunton, Va	44 months—July, 1861–Feb. 1865		833	191	22.9	4.3
General Hospital, Charlottesville, Va	26 months—July, 1861–Aug. 1863		647	207	31.9	3.12
General Hospital, Charlottesville, Va	15 months—Sept. 1863–Feb. 1864		187	37	19.7	5.05
[illegible] Hospitals in Virginia, out of Richmond	13 months—Jan. 1862–Apr. 1863		4,774	1,261	26.41	3.78
[illegible] Hospitals in Richmond, Va	Sept. 1862–April, 1863		1,627	405	26.50	3.70

Charity Hospital, Vienna, Dr. Skoda	**1843—3 years 5 months**	**Expectant system**	**392**	**54**	**13.77**	**7.27**
Edinburg Royal Infirmary, Dr. Bennett	**8 years**	**Rational Treatment**	**78**	**3**	**3.84**	**26.**
Kings College Hospital, Dr. Todd	**1847-1859**	**Antiphlogistic treatment**	**53**	**6**	**11.32**	**8.83**
Hospital la Charité, Louis		**Bleeding, Antiphlogistic treatment**	**78**	**28**	**35.85**	**2.78**
Hospital la Petie, Louis		Antiphlogistic bleed'g and Tar. Emet.	29	4	13.79	7.25
Hospitals la Charité and la Petie, Louis		Antiphlogistic bleed'g and Tar. Emet.	107	32	29.94	3.34
Massachusetts General Hospital, Dr. Jackson	1831-1835	Antiphlogistic bleed'g and Tar. Emet.	51	8	15.68	6.37
Royal Infirmary of Edinburg, Dr. Bennett and others	1812-1837	Antiphlogistic bleeding, calomel, etc.	50	19	38.	2.63
Royal Infirmary of Edinburg, Dr. Bennett and others	1839-1840	Antiphlogistic bleeding, calomel, etc.	648	222	34.26	2.91
Kings College Hospital, Dr. Todd	1840-1847	Antiphlogistic bleeding, calomel, etc.	25	4	16.	6.25
Hospitals of Milan, Rasori		Antiphlogistic, Tartar Emetic	842	173	20.79	4.8
Hospitals of Bologna, Tommasini		Antiphlogistic, Tartar Emetic	115	14	12.17	8.21
Clinic of Faculty of Medicine, R. Laennec	1824-1825	Antiphlogistic, Tartar Emetic	62	6	9.67	10.33
Clinic of Faculty of Medicine, R. Laennec		Antiphlogistic bleeding	...	...	......	6 to 8
Dr. Hellis, of Rouen		Antiphlogistic, Tartar Emetic	47	5	10.63	9.4
Hotel Dieu, of Nantes, Dr. A. Laennec	1823-1824	Antiphlogistic, Tartar Emetic	40	6	15.	6.66
Charity Hospital, Dr. Dietl		Antiphlogistic, Tar. Emet. large doses	106	22	20.7	4.818
Charity Hospital, Dr. Dietl		Antiphlogistic bleeding	85	17	20.00	5.
English Army in Crimea	1854-5-6		590	161	27.2	3.6
United States Army, Civil War of 1861-2	1861-July, 1862		11,061	2,134	19.2	5.1
Boston City Hospital	June 1st, 1864-June 1st, 1869	Dr. Bennett's plan	190	26	13.6	7.3
Charity Hospital, New Orleans, La.	1856-1860		801	300	37.3	2.6
Charity Hospital, New Orleans, La.	1866-1870		419	184	43.9	2.3
Charity Hospital, New Orleans, La.	1871		109	44	40.3	2.5
Charity Hospital, New Orleans, La.	1872		135	59	43.7	2.3
Charity Hospital, New Orleans, La.	1873		161	61	37.9	2.6
Charity Hospital, New Orleans, La.	1874		130	43	33.0	3.0
S. Ames, M. D., Montgomery, Ala.	1849, 1850-1-2-3	Quinine, Aconite and Phosphorus	68	2	2.7	34.

of Pneumonia, is coincident with and accompanies the progress of the local inflammation, and subsides when this is arrested. The length of the febrile excitement will depend upon, not merely the extent of the pneumonic inflammation, but also upon the character of the changes through which the altered lung tissue passes. In those cases in which the effused fibrinous effusion in and around the air cells is absorbed and developed into dense tissue, the fall of temperature is rapid and comparatively permanent. In those cases, however, in which the inflamed tissues undergo degeneration or disintegration, and abscesses of the lungs, with profuse expectoration of purulent matter occur, the temperature may remain at an elevated degree for indefinite periods of time.

When Pneumonia supervenes upon Phthisis, the elevation of temperature is rapid and fully as marked as that which occurs in uncomplicated cases; it appears, however, as far as my observations extend, that in such cases, the daily oscillations are greater, the morning temperatures being as a general rule, lower than in uncomplicated cases. When the pneumonic inflammation subsides, the temperature assumes the course characteristic of Phthisis.

I have drawn up the preceding table, with the design of determining, as far as possible, the relative value of the different modes which have been employed in the treatment of Pneumonia.

The important fact illustrated by this table is, that the mortality from Pneumonia, in a large number of Confederate hospitals (those entered upon the table were selected without any reference to the character of the statistics), was far greater than the mortality in this disease under different modes of treatment in European hospitals.

The mortality in these Confederate hospitals has been twice as great as that under Tartar Emetic in large doses, and about four times as great as under the Dietetic System, in which the powers of natare are simply supported, and drugs abandoned. These facts are surely sufficient to excite an earnest and diligent inquiry into the relative merits of the different modes of treating Pneumonia, now in use by Southern physicians.

It will be observed, that Dr. S. Ames, of Montgomery, Alabama, treated 68 cases of Pneumonia during a period of five years, 1849–1853, inclusive, with only two deaths, or a mortality of 2.7 per cent., or one death in thirty-four cases.

It remains that we should examine the method of treatment employed by this accurate and learned physician, which yielded such favorable results, in a highly malarious region.

The paper of Dr. Ames was published in the New Orleans Medical and Surgical Journal, January, 1854, pp. 417–441. For many years certain defects in the treatment of Pneumonia, by means chiefly of mercury, emetic tartar and blood-letting, had attracted the attention of Dr. Ames; and the dissections which he then made, showed that some of his patients dying between the sixth and tenth days, had a smaller aggregate of disease of the lungs than others who recovered had manifested, at any time in the attack, by physical signs. In connection with this fact, two things were noticed by Dr. Ames: *First*, that the fatal cases, having less disease of the lungs, were attended with certain complications and a new set of symptoms, which seemed very materially to influence the progress and result of the attack; and *second*, that these complications had a certain relation to the treatment. The complications were an ileo-colitis, with its attendant symptoms; a dry and red tongue, tympanitic abdomen, and diarrhœic or dysenteric stools; sometimes succeeded shortly after its advent, sometimes accompanied from the beginning by an affection of the liver and brain, giving rise to jaundice, delirium and coma. The relation of these conditions of disease to the treatment, was evinced by several circumstances. It was observed that those cases in which the treatment was begun early resulted less favorably, as a-general rule, other things being nearly equal, than those in which the treatment was begun later, and consequently was less protracted; that in the former the complications were more common, and when not fatal, the attack was more obstinate [illegible] followed by a slower convalescence; and lastly, it was observed that serious affections of the gastro-intestinal mucous membrane never occurred in the beginning of an attack, nor indeed at any time in the progress of it, before any treatment was begun.

Thus, the facts seemed very obviously to lead to the inference that these complications were produced by the deleterious agency of the remedies, or some one of them employed in the treatment. At the same time the nature of these new conditions of disease, in connection with the well-known toxicological properties of the medicines, while it served to confirm the former inference, pointed to the mercury and antimony as the only agents concerned in producing them. While either mercury or antimony are capable of superinducing these forms of disease when administered in Pneumonia, the accidents arising from the one are less frequent, and somewhat different from those arising from the other; the latter, however, being equally formidable when they do occur. An ileitis or gastro-enteritis is most common, and is the usual result of poisoning by tartar emetic. Mercury on the other hand, may induce an inflammatory state of the intestinal mucous membrane, less frequently, if ever, involving that of the stomach, and more frequently that of the larger bowels, and occassionally, it may about the same time, the liver and brain. When the two medicines are given together, the resulting complications are apt to involve all the structures mentioned, and it may be added, are more likely to occur. These complications were of the most formidable nature, always aggravating the pulmonary disease, and rendering it less amenable to treatment, they not unfrequently led to a fatal termination when death most probably would not have occurred from the pulmonary disease alone. The experience of Dr. Wm. M. Boling, of Montgomery, Alabama, was similar to that of Dr. Ames. Thus he affirms, that: "Among the cases of Pneumonia which we have treated with tartar emetic principally, we do not hesitate to say, that half as many deaths have occurred in consequence of gastro-enteritis—induced seemingly by the remedy,—supervening during the progress of the disease, or at the moment of apparent convalescence, as from the primary disease itself."*

With reference to *blood-letting*, the objections which Dr. Ames noticed in the course of his experience, to its employment to any great extent in Pneumonia, were presented in two aspects. In the first, a considerable mitigation of the symptoms has been obtained, which lasting but a few hours, has been followed by a reaction in which the disease has passed beyond the point of severity it had previously attained; that is to say, the pulse became in the reaction more full, frequent, and sometimes harder; the respiration increased in frequency, while the restlessness and general feeling of malaise were aggravated. Along with these untoward signs, there was commonly a more or less evident extension of the limits of the diseased parts. In this manner, the effect of one bleeding was to render the indications for another more urgent, and if repeated it was again followed by temporary relief and an ultimate aggravation; results which he has known to follow repeated diurnal or semi-diurnal bleedings, until the near approach of a fatal issue arrested the treatment. The observations of many years, satisfied Dr. Ames, that sudden and violent changes for the worse, of the kind here spoken of, do not occur in the progress of Pneumonia, unless bleeding constitutes an essential part of the treatment; or more accurately they did occur in one hundred and thirty-two cases not bled. Lænnec had previously made a similar observation, that in Pneumonia, by bleeding we almost always obtain a diminution of the fever, of the oppression, and of the blood expectoration, so as to lead the patients and the attendants to believe that recovery is about to take place; after a few hours, however, the unfavorable symptoms return with fresh vigor; and the same scene is renewed often five or six times, after as many vene sections.

The treatment of Pneumonia, which Dr. Ames finally adopted, consisted in discarding the three principal remedies in common use, and substituting others in their stead, after the following manner:

On visiting, for the first time, a person of adult age having Pneumonia in the first or second stage, pleuro-pneumonia or pneumo-bronchitis, the following prescriptions are made:

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* New Orleans Medical and Surgical Journal, vol. v, 1848, p. 291.

℞. Tincture Aconitum Napellus (saturated,) gtt, xii; Quiniæ Sulph. Vel. Ferro-Cyan., grains, xxxvi; Morphia Sulph., grain, i; m. ft. pil. xii.

℞. Solution of Phosphorus, gtt, xvi; water, 4 fluidounces,

Of the first, two pills are directed to be taken every third or fourth hour, usually every fourth, each dose being preceded one or two hours, by a teaspoonful of the phosphorus mixture. If an anodyne be required in addition to that contained in the pills, a quarter of a grain of Morphine is given at bedtime. If the disease is in the first stage, the beginning of the second, or after the second stage is fully developed, if there be much pain, not yielding permanently to anodynes, a large blister is directed to be applied over the seat of the disease.

The preparation of Aconite used, is a saturated alcoholic tincture, made by percolation through a pound of the bruised root alcohol enough to make a pint of tincture. This obtains, if the root be of the right species, is unmixed, and not too dry or too long gathered, a stronger tincture than that of Dr. Fleming, of London, whose paper on the therapeutic and toxicological effects of this drug, first suggested to Dr. Ames its employment as a substitute for bleeding and antimony.

The dose advised, two drops, may be considered a medium dose, when made up into pills, according to the prescription, or a full dose if given in water.

The curative influence of this medicine, though by no means dependent on doses sufficient to produce any poisonous effects, is, nevertheless, more promptly exerted, in proportion, as the latter are developed within certain limits. It is desirable, therefore, to give enough, or repeat the dose often enough to induce some nausea, or slight vomiting, particularly in the first stages of pneumonia. It is not needful to go farther, as a general rule, in order to get the best effects of the remedy, without, at the same time, harrassing the patient with its sickening influence.

On some occasions, however, when the attack wears an unusually threatening aspect, a more decisive impression may be required; and in such a case, it is better to repeat the dose more frequently, rather than enlarge it much. Under ordinary circumstances, the development of the toxicological action of the remedy, to any great extent, is not desirable; for if the dose be too large or be too often repeated, its effects may become exceedingly distressing to the patient, and alarming also to him and his friends. In such instances there occurs, more or less suddenly, a feeling of great prostration of strength and sinking; coldness, palor, and profuse sweating of the skin; pretty constant though not painful nausea; frequent attempts to vomit; purging; a slow, feeble, and thready pulse, and sighing respiration; to these symptoms there are added a dryness, or rather a feeling of dryness, and constriction of the throat; burning, tingling and numbness in the mouth, and numbness in the skin of the hands and feet, and frequently over other parts of the surface.

Children bear somewhat larger doses, in proportion to age, than adults. A child six or eight months old, can generally take one-fourth of a drop without inconvenience, and one twelve or eighteen months will frequently bear a third or a half a drop. The dose for adults and children, should be repeated, except in cases of unusual violence, at intervals of not less than three hours; in no circumstances ought the intervals be less than two hours.

The best effect of this remedy in pneumonia, like bleeding, is exerted in the first stage, or that of capillary repletion. After the second stage is completed, throughout the greater part of the inflamed structure, though not at all doubtful as a remedy, nor, indeed, any the less efficient or certain in its curative action than before, the latter is usually less promptly exhibited as regards both the rational and the physical signs. As a substitute for bleeding, it seems to possess several other advantages. While it reduces the force and frequency of the pulse with greater certainty, though somewhat less speedily, its action in this respect may be kept up for any length of time required, without fear of present or subsequent injury from it of any kind; if suspended, there is no tendency to any violent reaction in the circulation, nor, indeed, to any speedy febrile reaction at all, the pulse coming up to the natural standard, after having been brought below it very slowly. Hence, if it be thought desirable for any reason to suspend its administration during the night, no fears need be entertained of finding the pulse materially accelerated the following morning. Convalescence is never retarded through the influence of this remedy, and, unlike bleeding, it is safe, as well as efficient, in all circumstances of the acute disease, if used with but ordinary caution.

Dr. Ames was indebted to the representations of the value of phosphorus by his friend, Dr. James Berney, of Montgomery, for his employment of this remedy in diseases of the lungs. The solution of phosphorus, referred to in the prescription, is a saturated solution in Anhydrous Alcohol, diluted by nine additional parts of Alcohol. If the medical qualities of Aconite adapt it more especially to the first stage of pneumonia, so it may be said, those of phosphorus recommend it more particularly in the second and third stages. Given alone in the first stage, it is occasionally effectual in arresting the further progress of the attack, but cannot be depended on for this purpose with nearly the same confidence as Aconite alone. More frequently it does not prevent the second stage from forming, and decided signs of amendment are commonly deferred to the fifth or sixth day. While either Phosphorus or Aconite, within the experience of Dr. Ames is more efficient in either the first or second stage than any other single remedy, it is nevertheless desirable to obtain their combined action, as being more efficient than either, separately.

According to Dr. Ames, Phosphorus certainly acts as an expectorant, with great promptness and efficiency in pneumonia and bronchitis, in some forms of asthma, and in the bronchitis of asthmatic subjects. It is also an effective remedy in irritation about the neck of the bladder; in chronic or sub-acute inflammation of the inner membrane of the urethra and bladder; and also as a diuretic in dropsy. Its action on the lungs seems from its effects, to be directed especially to the minute bronchial tubes, and the air cells; and in inflammation, more especially to the capillary vessels than to the heart. Dr. Ames places Phosphorus in that class of medicines, which combine the properties of a sedative to the heart's action, and of a stimulant to the contractile force of the capillaries. These properties make them, as they have proved to be in practice, especially applicable to, and efficient in, acute inflammation and fevers; though applicable in all cases, whether chronic or acute, in which the vital power, and the force of the heart's action are equal to, or above the standard of health. In this class may be placed in the order of their relative value in acute inflammatory affections generally: first, Aconite; secondly, Antimony; thirdly, Phosphorus; fourthly, Quinine. Dr. Ames puts Phosphorus in this class, solely because of his own experience, and that of a few others, of its immediate sedative, or contra-stimulant influence on the general circulation, when given in a dose large enough to produce any sensible influence of any kind on the action of the heart, but still not large enough to excite inflammation or a high state of irritation of the stomach and bowels. Its sedative or contra-stimulant, is its medicinal or therapeutic effect. Its poisonous effects is the reverse of this, namely, highly stimulant by reason of the local inflammation it excites. There is a point at which it ceases to be medicinal or sedative, and becomes poisonous or stimulant. Thus it is not possible to produce by it the extreme depression which follows large doses of Aconite; for when the dose is enlarged for this purpose beyond a certain point, a new and opposite action is immediately set up, by which the power is lost or merged in the local inflammation, and its concomitant influence on the nervous system and the general circulation.

In the estimation of Dr. Ames, Quinine was a very important agent in the treatment of pneumonia, in the Southern States. If it be sometimes inefficient, it is also at times indispensable. When a malarious taint is an obvious complication, or when the pulmonic disease, seems as it were engrafted on an intermittent fever, no other remedy can be so confidently depended on. But this taint may exist, while the signs of it are so masked as to be detected with great difficulty. The excess of fibrin in the blood, the violence of the local inflammation, and the exalted state of the innervation, may overcome the tendency of the cause of periodical fever to manifest itself in the usual way. Hence, it becomes a safe rule to begin the treatment of pneumonia in malarious districts (so-called,) by making quinine a component part of it.

The custom of Dr. Ames was to give it in the manner specified, until its peculiar effects on the head became very well marked, and if the signs of amendment are not then satisfactory, or such as may be properly attributed to the quinine, to discontinue it, and give the Aconite in water.

Dr. Ames regarded blisters as important adjuncts in the treatment of pneumonia. He found them to be most beneficial when applied in the first stage of pneumonia. So applied, they never seemed to produce any general irritation, were prompt in relieving pain, and appeared to assist in resolving the local inflammation.

Morphine, (or Opium), besides its occasional use as an anodyne merely, was introduced into the plan of treatment, in order to effect two special objects. One of these was to prevent any irritation of the bowels, or to remove it if present. The tendency of the disease is to take on this kind of complication, which, when it occurs, always aggravates the danger of an attack, as well by its unfavorable reaction on the primary affection, as by the presence of disease in the two vital organs instead of one. The predisposition to an enteric complication is sometimes so strong as to be developed into active disease from very slight causes; even Quinine, slightly irritative as it is, may produce this effect. Hence the advantage of combining the opiate with it, and of so timing the doses of the opiate as that its quieting effect on the bowels may be continuous. The rule with Dr. Ames was to keep the bowels quiet, cathartic or even aperient medicines forming no part of the treatment.

The other object was to prevent inflammation of the pleura, which Dr. Ames endeavored to accomplish by the judicious use of opiates, and occasionally by the aid of blisters.

In his opinion, the fears so often expressed by systematic writers, in regard to the use of opiates before the acute febrile excitement is subdued, and the apprehension of their aggravating the inflammation by checking expectoration, was altogether unfounded.

In noting the cases, Dr. Ames followed the rule of excluding all cases of disease of the lungs in which the diagnosis of Pneumonia could not clearly be made out, as well as those in which the pulmonic inflammation was not the primary and predominant disease. Of the 68 cases recorded upon the table of Dr. Ames, 19 were whites and 49 blacks. Both of the deaths occurred amongst the blacks. In nine cases both lungs were affected, and in forty cases the inflammation was confined to the left or right lung.

We have thus endeavored to give a thorough and impartial analysis of the paper of Dr. Ames, as it appears to be the most important contribution to the therapeutics of Pneumonia which has ever emanated from Southern physicians.

In 1866, I submitted the tabular statement of results of the treatment of Pneumonia in various Confederate and European hospitals, together with an outline of my investigations on the relations of malaria to Pneumonia, to four medical gentlemen in whose ability and judgment I had confidence, and these practical observations on the treatment of Pneumonia, will be concluded with extracts from their replies.

CHARLOTTESVILLE, UNIVERSITY OF VIRGINIA,
May 1st, 1867.

DR. JOSEPH JONES:
My Dear Doctor:

* * * * * *

I do not remember to have seen anywhere else, as just and as philosophical a view of the subject, or as clear a statement of the way in which the presence of the malarial poison may predispose to inflammation of the lungs.

Your table of the mortality of Pneumonia, under different modes of treatment, has furnished me food for much reflection. The death rate at our Hospital, exceeded any that occurred in the Confederate service, except at Atlanta. And as the treatment consisted (so far as I controlled it,) in carefully supporting the patient by nutritious food—gentle revulsion by turpentine stupes or light blisters, the use of saline diaphoretics, and the timely administration of stimulants, I feel reluctant to accept the obvious inference that the enormous mortality was due to the plan we pursued. And my difficulty is increased by the recollection that our quarters were comfortable, and the corps of nurses both ample and excellent.

Will the fact that our Hospital was next to Lee's Army, and consequently arrested the worst cases, both of sick and wounded, (many of such cases arriving in a moribund condition,) furnish the desired explanation ?

Or is it possible that the diagnosis was more rigorous at some points than at others. ?

I find the results of the treatment which I have indicated, so satisfactory in Civil Practice, that you will excuse me for doubting whether it deserves the credit of the Confederate Mortality at Charlottesville. * * *

Believe me, my dear Doctor, very sincerely and kindly, your friend,
J. S. DAVIS.

PHILADELPHIA, December 8th, 1866.

DR. JOSEPH JONES:

My Dear Doctor:—I should sooner have replied to your letter of the 12th ult., but from two causes; 1st, in consequence of absence in the country I did not receive it in due time, and 2d, when it reached me I was very unwell, and have continued so till near the present time.

I find from your letter that, at the time you wrote, you had not received a copy of the just completed 6th edition of my Practice, which I requested my publishers to send you in my name, and which I presume was on its way to you, at the moment of your writing. By consulting my observations on Miasmatic or Bilious Pneumonia, (vol. 2d, pp. 18 and 31,) you will find that I fully recognize with yourself the frequent connection of pneumonia and marsh miasm, and the importance of the use of quinia in the complicated affection. My owu experience long since abundantly convinced me that quinine is not only capable of curing this form of Pneumonia, but is often essential to a cure.

I looked over your article, and was gratified by the amount of observation you had collected; but I hope to be able to do it more justice hereafter. * *

You will have noticed that I write with difficulty. My nerve centres have been so much debilitated by age, etc., that it is even painful for me to use the pen; otherwise I should have written probably much more fully on your paper; as Pneumonia is a subject in which I have been much interested. * *

Very truly, your friend,
GEO. B. WOOD.

PHILADELPHIA, NOV. 22, 1866.

Prof. Joseph Jones, M. D.:

MY DEAR DR. JONES—Your favor of the 12th inst., has reached me, and demands my acknowledgment and thanks. I have read your paper on Pneumonia, with much pleasure. I agree with you fully in your views of its relations with malaria, and have always considered it an error to confound it—an incidental disease, arising from non-specific modes of causation, with the maladies produced by a morbid agent, a specific poison, limited in its source.

Your tables are of high value. Our worst mortality in the Confederate Hospitals (Atlanta No. 1), is very little—a mere fraction above that in Paris and Edinburgh, under Louis and Bennett—and our average quite as favorable as that of the United States, as given in circular No. 6, one in four and a fraction, and that of the English in the Crimea, one in four. When we consider that the United States had all the world to draw upon in providing necessaries and comforts—setting aside medicine altogether—and that we were absolutely destitute in many places, and comparatively so everywhere, the result is consoling though not pleasant.

Nothing seems stranger than the contrast of statements which are presented in good faith by the compilers of statistical records. In every Bill of Mortality that we take up, we find Pneumonia occupying a prominent place, perhaps, generally the second, Consumption being first. In Ramsey's table, for thirteen years, of New York mortality, Consumption yields 37,038; Convulsions 23,063; Marasmus 18,696; Cholera Infantum 16,331; Pneumonia 15,138 + Inflammation of Chest 168 + Congestion of Lungs 3,230 = 18,536. But Convulsions, Marasmus and Cholera Infantum, are vague words; and Inflammation of Lungs stands fairly second on the list. From Philadelphia tables, just at hand, for six years inclusive, 1858–1863, I take the number of deaths ascribed to Pneumonia (Inflammation of Lungs) 3781.

Now, when I find Bennett affirming, in his late pamphlet, that all his patients get well, and others making similar statements, with a little modtfication, I am amazed and humiliated. If all cases "tend to recovery," how have so many thousands been hindered from this natural termination, and "done to death?" If by the interference of our Profession, the sooner we disband the better.

I have seen very few cases die of Pneumonia, complicated or uncomplicated; but I have been unfortunate enough to lose one occasionally in my large and long practice. Yet I never attend one without flattering myself that I had been of some use to him—either palliating his sufferings, or, if I could not save, prolonging his life.

Hospital cases, my dear Doctor, do not offer fair tests, as thus: if a wretched pauper be brought from a miserable and filthy hovel into a comfortable ward, cleansed, warmed, clothed, fed—he undergoes a change of condition far more impressive than all the appliances of the Materia Medica could effect—a change for the better, hygienic, curative, in every way restorative.

But select cases, in good houses, in a city, and change nothing of their surroundings; let one hundred be poulticed and dieted, or left to quiet rest in bed, and treat another hundred with Quinia, a few with the lancet pro re-nata, above all with Opium or with Calomel—all in prudent moderation; obtain statements from the intelligent among them as to the alleviation of suffering, note the duration of the cases, the proportional mortality, and the bodily vigor and restoration of organic integrity of the convalescents. These would be instructive records, and when extensive and varied enough, would be conclusive. At present, we must continue doubtful and anxious—such is the destiny of the reflective physician, certainty seems unattainable, but "Probability is the Rule of Life," and I think it probable that we do rather more good than evil.

Vive et vale Dear Doctor, and use Time to add to our useful knowledge.

Yours, with great esteem and regard,

SAM'L HENRY DICKSON.

PHILADELPHIA. *December 6th*, 1866.

DOCTOR JOSEPH JONES:

My Most Esteemed Friend, * * * * *

I have read with much interest your paper on Pneumonia and Malaria. I endorse every word of it except *protiene*, (there is no such organic body—albumen or albuminoid expresses the truth.) I go further, healthy inflammation not merely limits disease, it cures and extinguishes it, and it disappears. When perfect hepatization—the second stage of Pneumonia has taken place, the primary affection which preceded and induced inflammation is strangulated by the coagulation of healthy fibrin: all vital action, circulation, inervation, nutritive action, all are terminated, the tissue is reduced in structure and vitality, to cartilaginous tissue or even below it.

December 8th, I had proceeded thus far, when I was interrupted, and soon after was seized with a most furious attack of Neuralgia, which continued all yesterday: and to day my head has been a "muddle," from the opiates with which I was compelled to stupefy my nervous sensibility.

Now to resume our subject, John Hunter was the first who recognized that inflammation was a salutary process, a therapeutic agent of nature. Inflammation of that type or nature, he called healthy inflammation; but there was another type or kind of inflammation, which not only failed to arrest or to influence a diseased state favorably, but actually to aggravate it; that he named unhealthy inflammation. He could not account for the difference. The *capital fact* of inflammation had not then been ascertained: we are indebted for it to Andral and Gavarret. It is that inflammation develops fibrin in the blood. It is the blood that determines the type of inflammation. When the crasis of the blood is normal, the fibrin possesses its plastic properties in a perfect state: it coagulates firmly, glues tissues together, and consolidates loose spongy tissues, and reduces them to the lowest type of structure—all vital action, normal or pathological, is arrested. This is healthy inflammation. But if the crasis of the blood be deteriorated, or contaminated, inflammation does not convert albumen into fibrin, or produces an imperfect uncoagulable fibrin, and this is unhealthy inflammation. It fails to arrest the disease. In Pneumonia there is no second stage—rales in the lungs and bloody sputa continue to the end—always fatal.

For a period of forty years Pneumonia presented its normal type, running through its first second, and third stages. Except in double pneumonia, the death rate was small. About 1857 or 1858, a change took place; many cases remained in the first stage—the second stage aborted; no perfect hepatization occurred; and all such were fatal. A number of our respectable citizens were victims; as Dr. Hare, Dr. J. K. Mitchell, Judge Kane, and others. Cases are now less frequent, and I am not informed as to its present type. Cases of Pneumonia have been diminishing for the last five years, and I have not been able to ascertain whether it has resumed its normal type of three successive stages.

What you say of Malaria is perfectly correct. There can be no doubt that it frequently exists in a dormant state, and is excited into activity coincidentally with the development of another disease. I have not met with it in Pneumonia; but in a period from 1820 to 26, when we had all forms of malarial diseases in the summer, cases occurring in the winter frequently assumed the intermittent type.

My dear Doctor, I have made an effort to write though with difficulty, I fear you will find it difficult to read what I have written—my fingers are so stiff, and my hand unsteady, that writing in long letters is almost illegible.

* * * * * *

Adieu my last, best friend, but most esteemed,

SAMUEL JACKSON,
224 *South-Eighth Street.*

OBSERVATIONS

ON DISEASES OF THE

OSSEOUS SYSTEM.

MOLLITIES OSSIUM

(MALAKOSTEON, OSTEO-MALACIA, OSTEO SARCOSIS, KNOCHENERWEICHUNG,
RACHITISMUS ADULTORUM. RICKETS, OR SOFTENING OF
BONES IN THE ADULT.)

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BONES IN THE ADULT.)

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CHAPTER XX.

CASES ILLUSTRATING THE NATURE, PROGRESS, TERMINATION, AND ANATOMICAL LESIONS OF MOLLITIES OSSIUM.

Case of Miss Bozel, observed by the author. The origin of the disease referred to constitutional derangements rather than to a strictly local disease of the bones. Cases reported by Sylvanus Bevan, Ambrose Hosty, John Pringle, J. W. Tenney, Thomas R. Chambers, Samuel Solly, and others.

My attention was directed to this singular disease by the following case: Miss Raney Drucilla Bozel—and after comparing this case with others, we thought that it would not prove an unprofitable task to bring forward such a collection of cases as would illustrate more fully than has yet been done, the main features of the disease. Such an inductive investigation of this rare disease appeared to be more especially appropriate, as the records of its history are scattered in fragments in journals and systematic treatises.

CASE 767: Miss Raney Drucilla Bozel, Nashville, Tennessee, October 1, 1868; was called by Mrs. Bozel to attend her daughter, Miss Raney Drucilla Bozel, age 18, of humble parentage, who had always lived in great poverty. At the present time the patient, Miss Bozel, together with her father, mother, and younger sister, occupy a small room about ten feet square in a wooden building, erected by the U. S. Government during the war, at the foot of Fort Naglie; the entire family is supported chiefly by alms, the mother's attention being taken up principally with the care of her sick daughter, and the father being aged, feeble, and afflicted with an eruption upon the skin, and an indolent ulcer upon the back.

The father, mother, and Miss Drucilla, all present pale, cadaverous faces, resembling those who have long been subjected to the action of malaria.

Miss Drucilla was born in Bedford County, Tennessee, three miles from Shelbyville, in a healthy locality, and her mother states that she was a healthy child up to the age of five years, when they moved to Southern Illinois, and settled on an island in the river, opposite Paducah, Kentucky.

The island lay in Madison County, Illinois, between the Tennessee and Ohio Rivers, was low, and subject to overflow. The island was overflowed the year after the removal of the family, and at this time the lower part of the house was under water, and the house occupied by the family, as well as the surrounding grounds, continued damp during a considerable portion of the spring and summer; the freshet occurred in the month of May. Shortly after her removal to this low, malarious situation, Miss Drucilla, who up to this time was an active, healthy child, was seized with the *ague*, and sufferred with it for *eighteen months.*

The softening of the bones commenced just after the freshet, and whilst she was suffering severely with malarial fever, and whilst the house and surrounding lands were damp, and covered with the river deposit. The bones of the leg first became painful; poultices appeared to relieve the suffering temporarily. Then the jaws were attacked, became painful, and both the upper and lower jaw upon the left side became carious, and have continued occasionally to discharge pus and small fragments of bone up to the present time. The diseased surface sometimes heals up, but breaks out again.

About three years ago the left arm began to lose its bone, and has apparently lost all the earthy matter of the humerus for the space of some five inches. The mother states that this loss of the substance of the bone was attended with great pain.

At the present time the middle portions of the humerus of the left arm have apparently disappeared, or been converted into a flexible cartilaginous mass, only about two inches of hard bone remaining at the upper humeral and lower ulnar articulations. The arm can be bent at right angles to the natural course of the humerus, and it can be twisted around its centre; and it feels in this portion like a mass of flesh. The fore-arm and hand of the left side present a natural appearance. The right humerus of right arm feels rough and enlarged, and is painful to the touch. Ulna of right arm apparently of natural length, but anterior portion projecting outwards, and the hand thrown inwards. Radius apparently destroyed, or converted into soft flexible material, throughout a considerable portion of its extent.

Right thigh and leg much less affected than the left. Knee-joint of right leg much swollen, with distinct veins; ankle-joint much deformed the fibula projecting beyond the ankle, and the lower portion of the tibia converted into soft, flexible material, shortened and diminished in size. The marks of several ulcers are visible upon the right leg.

Left leg—tibia and fibula divided or absorbed in the region of the upper third, and large masses of a hard nature—like the callus of the fractured bones in healthy individuals—have been thrown out around the extremities of the bones. Her mother states that this bone was fractured at night, whilst the patient was lying in the bed, and that the fracture was attended with an audible snap. If the statement was correct, the fracture was occasioned by the action of the muscles of the thigh, after the weakening and absorption of a large portion of the shaft of the bone. The correctness of the statement is sustained by the existence of callus around the extremities of the bones.

Left foot and ankle in place and of good shape.

Patient suffers with continued pain in left side of the head; sight in left eye much impaired, and eyeballs very prominent, as if the [illegible] had been thickened and the soft parts pushed forward. At times [illegible]

Complexion sallow, with [illegible]

[illegible]

3d. The regulation of the bowels, which had been habitually constipated or costive.

4th. The restoration, or rather the establishment of the function of menstruation.

We sought to accomplish these results by the administration of fifteen grains of a mixture of equal parts of the phosphates of iron and lime in a cup ot rich, fresh milk, three times a day; by an alterative plan of treatment, consisting of iodide of iron and iodide of potassium (℞. Syrup of iodide of iron, one fluidounce; iodide of potassium, two drachms; syrup or ginger, eight fluidounces—mix. Teaspoonful in wineglassful of water three times a day); and by the regulation of the bowels and uterus by the pills of aloes, rhubarb, and myrrh of the United States Pharmacopœia, and the administration in liberal quantities of digestible and nutritious diet.

Under this treatment, the menstrual function was established, (in the language of her mother, "she became a woman"), the general health improved, and the head symptoms were alleviated.

In the latter part of December, my residence was destroyed by fire, and having to transfer my family to Georgia, and amid a pressure of cares and labors, I lost sight of this case; previous to this, the mother was in the habit of calling at my office every day for advice and assistance, and my visits also were at regular intervals.

I was subsequently informed by her mother, that Miss Drucilla died after a brief illness, on the 1st of February, 1869. I could gather nothing more than that the illness was brief, and that both the stomach and head were deranged about the time that the menses should have appeared.

The connection of this case in its origin, with a severe and prolonged attack of malarial fever, during exposure for months to a damp, unhealthy, malarious atmosphere, is interesting and important.

I have elsewhere shown that the malarial poison not only destroys the blood corpuscles more rapidly than any other febrile poison, but also *diminishes the phosphates of the blood.* (*Observations on some of the Physical, Physiologisal, and Pathological Phenomena of Malarial Fever, Transactions of the American Medical Association, 1859*).

Rapid destruction of the bones, as well as of the integuments and muscles, has been sometimes witnessed as one of the results of the action of malaria upon the human system, and I have elsewhere recorded such cases (*Transactions American Medical Association, 1859*): and, in March, 1869, I had in my wards in the Charity Hospital, a case of chronic malarial poisoning, in which one leg had been destroyed by extensive ulceration, and the other leg was threatened by large ulcers. A careful examination of the histories of these cases demonstrated that the destruction of the tissues could be referred neither to the action of mercury nor the effects of acquired or hereditary syphilis.

It is possible that in certain stages of malarial fever, and in certain states of the human system, acids, as the phosphoric and lactic, capable of acting upon the inorganic constituents (or mineral elements of the bones, phosphate and carbonate of lime, and phosphate of magnesia,) may accumulate in the blood and structures, and cause a solution and absorption of the earthly matters. By numerous analyses of the urine in malarial fever, I have shown that during the chill, and at the very commencement of the hot stage, phosphoric acid disappears almost entirely from the urine, whilst the organic acids and sulphuric acid are increased; as the hot stage progresses. and the febrile action and the heat commence to decline, there is an augmentation of the phosphoric acid; the uric acid is either increased or remains at the normal standard during the chill, disappears almost entirely during the fever, and then increases rapidly and rises to a high figure after the subsidence of the febrile excitement, and often continues for days, two, three, and even six times more abundant than in the normal state. The salts of lime contained in the urine also undergo marked variations in quantity during the different stages of malarial fever, diminishing during the chill and first stages of the fever, and increasing as the febrile excitement declines. In the first stages of the paroxysm the phosphoric acid appears to be, to a considerable extent, free, and uncombined either with the alkalies, soda and potassa, or lime; after the continuance of those changes, which result in the increased formation of phosphoric acid in the nervous and muscular structures, the insoluble phosphates of the structures appear to be dissolved, and hence the accumulation of the salts of lime in the urine. On the other hand, the chloride of sodium, a highly soluble salt, increases in the earlier stages, and diminishes in the urine during the intermission or remission.

The pale, sallow, aæmic hue of this patient, together with the rapid, feeble pulse, and periodic febrile excitement, indicated profound alterations in the composition of the blood, and derangement of the nutrition of the organs and tissues.

It is not unreasonable to refer the origin of the disease in this case to the derangement of the blood and nutritive acts by the presence and continued action of a specific poison, especially as this disease is known to originate most frequently amongst the ill-conditioned and ill-fed inhabitants of large manufacturing towns, and in females whose menstrual function had been deranged for long periods, and whose forces had been depressed by the demands made upon the nutritive elements by repeated pregnancies.

In a word, we are disposed to refer the origin of the disease in this case to constitutional derangements. rather than to a strictly local disease of the bones.

This conclusion is further sustained by the fact that a large proportion, if not all the cases of mollities ossium heretofore reported, exhibited marks of constitutional derangement, fever, wasting, and abnormal condition of the urinary secretion preceding and accompanying the local disease in the bones.

We cannot regard the osseous tissue solely from a chemical point of view; neither is it correct to regard it as a simple, uncomplicated texture. In addition to the phosphates and carbonates of lime and magnesia, which might be regarded as comparatively devoid of vitality, bone presents a complicated structure into which the most highly vitalized and most complex tissues, as vessels and nerves, enter. The numerous cavities and canals which penetrate the fresh bones are not empty, but contain a true nutritive plasma, complex in its constitution, derived primarily from the blood circulating through the osseous tissue, and obtaining its physical and chemical elements directly from that fluid, and in common with all the other fluids of the body, subject to physical laws of endosmosis and absorption, and to chemical changes. The investigations of Virchow, Donders, and Hope, have even rendered it probable that the bone-corpuscles and their prolongations are lined by a membrane, and cannot, therefore, be viewed as simple excavations in the compact structures.

It is not unreasonable therefore, to refer certain structural alterations of the bones to derangements of the blood, from which the nutritive fluids and plasma of the cellular spaces are derived. While an excess of earthy salts in the blood, conjoined with an increased alkalinity, may tend to the deposition of phosphates, on the other hand an increase of acid in the blood, whether received from the alimentary canal by absorption, or from the mal-assimilation of the elements of the nutritive fluids, or from some arrest or perversion in the process of secretion, would tend to the solution of the mineral constituents of the osseous system.

In the following case, reported by Sylvanus Bevan,* thesoftening of the bones was preceded and accompanied with a frequent and copious discharge of urine, gradual wasting of the body, hectic fever, quick, feeble pulse, thirst, pains in the shoulders and limbs, and loss of appetite. After the continuance of these symptoms during the period of two years, accompanied with great emaciation, the patient was attacked with an intermittent, which appeared to alter the character and quantity of the urinary discharge, and, after the relief of the intermittent fever, the appetite returned, the breathing became freer, and the hectic fever was much lessened; but the pains in the limbs continued, and, after being confined to her bed for several months on account of the weakness and pains in her limbs, the bones of the legs became soft and pliable.

Case 768: The wife of one B. S., in the year 1738, was taken with a diabetes, with the usual symptoms, viz: a frequent copious discharge of urine, a gradual wasting of the body, a hectic fever, with a quick, low pulse, thirst, great pains in her shoulders, back and limbs, and loss of appetite. She continued thus two years, much emaciated, though using the common medicines; at which time she was attacked with an intermittent, which soon left her; after which the diabetes gradually decreased, so that in a few months she was free from that disease, but the pains in her limbs still continued. She recovered her appetite, breathed freely, and her hectic much lessened, though she had some appearance of it at times.

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* An extraordinary case of the Bones of a women becoming soft and flexible. By Mr. Sylvanus Bevan, T. R. S. Philos. Trans., vol. xlii, 1743. No. 470, p. 488.

About eighteen months since, she had such a weakness and pains in her limbs, that it confined her to bed altogether; and in a few months the bones in her legs and arms felt somewhat soft to the touch, and were so pliable that they were bent into a curve; but for several months before her death they were as limber as a rag, and would bend any way with less difficulty than the muscular parts of a healthy person's leg without the interposition of the bones.

April 12, 1742, after a tedious illness, she died, near the age of forty, and, with the consent of her friends, a post-mortem examination was made. On raising the cutis, the membrana adiposa was found much thicker than was to be expected in a person so much emaciated; the sternum and ribs, with their cartilages, were very soft; and all the cartilaginous parts of the ribs, at their articulations, from the clavicle downwards, were doubled over each other, on the left side, about an inch. On raising the sternum, he found that the lungs adhered close to the ribs for four or five inches on each side, but were more loose and flaccid than usual, and much less in size; her heart was of the common size. Upon viewing the liver, it was found to be at least a third part larger than common; the spleen was about half an inch in the longest part, and a quarter of an inch thick; the intestines were very much inflated. She had appearances of several anchyloses formed in the small joints, viz: carpal and metacarpal bones; but, on laying them open, Dr. Bevan found them only like a thin shell. The cartilaginous epiphyses of the bones were entirely dissolved, and no parts of the heads of the bones remaining but an outside not thicker than an egg-shell.

On making incisions in her legs and arms, five or six inches long, Dr. Bevan found the outer laminæ of the bones soft, and become membranous, about the thickness of the peritoneum, containing, instead of a bony substance, a fluid of the consistence of honey, when it is thick, of a reddish color, not at all disagreeable to the smell. There was no appearance of any bones in her leg and arms, except near the joints, which were in part dissolved, and what remained were very soft and full of holes, like a honey-comb; also the bones of the head would easily give way to the pressure of the fingers. It is remarkable that those parts of the bones that are most compact and hard were first dissolved, while their heads, which are more spongy and soft, had not so entirely lost their substance.

When she was in health she was five feet high, but after her death she was but three feet seven inches in length, though all her linbs were stretched out straight, which is seventeen inches shorter than she was in health.

In the following case of Anne Elizabeth Queriot, of Paris, reported by Ambrose Hosty, the disease occurred after pregnancy, and was attended with great pain and weakness in the limbs, with an abundant white chalky sediment in the urine, which fermented strongly with acids; dead, œdematous state of the flesh; rough, scaly skin; increased heat, cough, laborious respiration and spitting of blood, and black sputa which stained the napkins, and also with a peculiar sweat, which stained all the linen that touched her skin. The attendant physician supposed that the phosphate of lime was discharged both by the skin and kidneys, and in the sputa.

CASE 769:* Anne Elizabeth Queriot, aged 35, native of Paris, was married in the year 1746, was brought to bed in 1747, and for the first time complained of great weakness in the small of her back, loins, and thighs, and could scarcely walk. A second lying-in, a year after, removed her complaint for about six weeks, after which it returned. In the year 1749, being two months and a half with child, she was seized with a loss of blood, and miscarried. Two months after, she fell on her left side, which gave her great pain in her leg, thigh, and hip of that side, and made them swell; but there was neither fracture nor dislocation. Her pains, after some time, abated; but the weakness of her limbs continued.

She was a third time with child, which revived her former pains, and caused her pains all over her body, with a swelling as before. This confined her to her bed, yet her pregnancy terminated favorably, after which the swelling went off; but her limbs were so weak that she could not stand upon her feet.

In about six months after her last lying-in her pains returned worse than before; and about the same time an abundance of white chalky sediment appeared in her urine, and the forefinger of her right hand was observed to be distorted towards the little finger, which was the first appearance of the dissolution that ensued. Soon after, the lower extremities began to turn upwards gradually, and almost in a parallel line with the body, and continuing till, in nine months, her lower limbs were turned upwards. All the bones were affected, especially the thorax, which had lost its natural form and capacity, and she was altogether miserably distorted.

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* The Case of Anne Elizabeth Queriot, of Paris, whose Bones distorted and softened. By Ambrose Hosty, M. D., of Paris. Philosophical Transactions, 1753, vol. xlviii, p. 26; Abridgment of Phil. Trans., vol. x, pp 313-316.

This miserable state was attended with exquisite pains, and according to the seat of them the patient used to say, "Now, such a part works." Sometimes they abated, and then she felt so sore as not to bear being touched; and during this case from her pains, a quantity of the aforesaid sediment passed by urine, though little or none passed during her sufferings. It was quite cretaceous, and, reduced into a fine powder, fermented gently with acids. She could bear no covering but a few napkins, both from inward heat, and to avoid loading her breast. Notwithstanding her preternatural posture, the evacuations by stool and urine were regularly and easily performed. Her flesh seemed dead and œdematous, the skin rough and scaly, so that a modification was often apprehended. She had a cough, a laborious respiration, and sometimes a spitting of blood, from the coarctation of her breast, all its bones plying inwardly. She was capable of no other motion than turning her head on both sides, stirring her left arm in the shoulder-joint only, and separating her fingers, but not bending them. She had her menses regularly till about three months before her death. She generally had a low fever, inward heat, sweats, and restlessness. Her fever ran very high in August, attended with delirious headache, raving, and subsultus tendinum. A little before her death, came on a deafness, a dimness of sight, a scalding of her eyes, and a constant dropping; violent pains in her head—in short, a great weakness in all the organs, which showed how much the head was affected.

The distortion of her limbs went so fast in August and September, that almost every day something new was observed; especially the left foot, during that time, came down gradually near eighteen inches from under her ear, where it lay before. It was also observed, in August, that her neck grew visibly smaller, the thorax much narrower. And then the napkins in which she spit grew black in washing, and stained as from the mercurial ointment; though this cause was not suspected, as it could not be learned that she had ever used any mercury. In a month after he observed the same thing on all the linen that touched her skin. He got a napkin rubbed with soap, then dried, and afterwards washed. This method had almost taken off the stains, as it does those from the mercurial ointment. Her linen stained all the washing, like linen impregnated with it. These spots appeared on the linen a mixture of a cretaceous matter and grease. Since this remark was made, more of the white sediment was seen. This and the apparent nature of the stains, made him believe that it was then discharged by the spittle and the pores of the skin, and mixed with oily particles of her fluids, which had acquired a quality analogous to that of mercury, of staining all linen. Dr. Hosty was also led to think that this sediment was the earthy matter that gives the bones their solidity and hardness, which had been dissolved by the same vitiated quality of the fluids, and evacuated by the emunctories already mentioned.

After great sufferings she died the 9th of November. Her body was opened in the presence of some of the most celebrated anatomists and academicians of Paris. The operation was begun on the left tibia, cutting on the fore-part of it from below the knee to its basis. It was wonderfully altered; more or less soft in all its length; in some points entirely dissolved, and its sides not thicker than the gristle of the ear. The spongy substance of its extremities supple, yielding to the least pressure. The reticular matter was quite destroyed. The perone was entirely dissolved in the middle, and only slight marks of its extremities remained. Instead of marrow, they found in all the bones a red, thick matter, like coagulated blood, mixed with grease. The rotula was entire, but very soft and spongy; the condyles of the femur the same. All the cartilages were found in their natural state. The head of the humerus was much diminished and flattened, its middle part very small, pliable, softened in all points, yet in some friable.

The cubit and radius suffered the same alterations with the humerus. By stretching all her limbs, they laid them straight; but they soon after returned to their former curve. The phalanges of the fingers were not so much softened, but were easliy cut and bent like whalebone. The femur was rather a fleshy body than a bone; its cavity was filled with a reddish suet, instead of marrow, which accumulated in different points, and bulged out the fleshy sides. The capacity of the pelvis was much diminished; the bones that composed it were softened, thickened, and contracted. The spine kept its natural form; the vertebræ soft and supple. The sternum and all the cellular bones seemed solid, but could bend, and were easily cut. The ribs, though softened, were still friable. Some of them, toward the sternum, were doubled over each other. The clavicles seemed almost cartilaginous. The shoulder-blades were much thicker than natural, less broad, and entirely disfigured. The two protuberances called acromion and coracoides, almost joined. The skull bones were easily cut in slices, and were twice as thick as in their natural state. Both plates were joined in one, and no trace at all of a diploe. Their substance abounded with an extremely diluted serum, easily squeezed out by a gentle pressure of the fingers. The sutures almost obliterated; the bones of the basis and the face shared in the calamity. The teeth hard as usual. The dura mater was incorporated with the bones. The brain not softer than ordinary; its right hemisphere was, by one-third, larger than the left, and, hence, perhaps, the weakness of her left side, often manifested by pains, aches, defluxions, heaviness, falls on that side, and every illness which she had from her infancy, beginning in some part of it. When young, she fell on her head, down two pairs of stairs. The membranes that separate the two hemispheres of the brain were much thicker than common. In fine, all her bones were so soft, that the scalpel, with very little force, ran through the hardest of them, even the rocky apophysis of the ear bone, so called from its excessive hardness.

Nothing extraordinary was found in the viscera: but their size diminished by the compression, and a universal cachexy.

There could be no cause assigned of this woman's disorder, as she gave no signs plain enough to prove either a scurvy, pox, or king's-evil, either hereditary or acquired; her parents having lived healthy, the one to the age of eighty, and her mother being then living, aged sixty, and in good health. She had three children, who died of disorders common to their age; one four years old, died of the measles.

In the following case of Mary Hays, reported by John Pringle, the patient suffered first with chlorosis (green sickness) and suppression of the menses, and was seized with pain universally attended with feverish symptoms.

CASE 770: Mary Hays,* of Stoke-Holy-Cross, near Norwich, gave the following account, June 21st, 1752: That she was born January 11th, 1718, and never married, nor was addicted to any kind of intemperance; that her father was unhealthy a great part of his life, but she knew not what disease he was subject to; that her mother died when she was a child, but she did not remember having ever heard of her being unhealthy; that she, herself, was always considered as a healthy, strong girl, till about fifteen years of age; then fell into the green sickness, and took various medicines to no purpose; that this disease, as far as she could recollect, was all she had to complain of, doing the ordinary work in a farmer's house till October, 1784. She then was seized with pain universally, attended with feverish symptoms. Thus she continued seven weeks, after which the pain was chiefly confined to her thighs and legs, but not increased by external pressure.

In September, 1749, she broke her leg as she was walking from the bed to her chair, without falling down, and heard the bones snap. The fracture was properly treated, and regard had to her disposition; but the callus was generated, the bones growing flexible from the knee to the ankle in a few months, as did those of her other leg. Soon after, those of her thighs were visibly affected in like manner. Both legs and thighs became œdematous, and subject to excoriate, discharging a thin, yellow ichor. The winter after breaking her leg, she had symptoms of the scurvy, and bled much at the gums.

Many emnient physicians, who were of opinion that this disease of the bones might arise from acidity abounding in the blood, prescribed for her, but without effect, unless the regularity of her menstruation for the last eighteen months may be attributed to a chalybeate medicine, though medicines of that nature had no effect formerly, when she was in a condition to take exercise and regularly persisted in the use of them.

For some considerable time past she had found little alteration in her complaints in general, though her appetite and digestion were rather better, but that the difficulty of breathing, which she had long labored under, gradually increased, and the thorax appeared so much straitened as necessarily impeded the expansion of the lungs.

Her spine became much distorted, any motion of the vertebræ of her loins, gave extreme pain, and her thighs and legs were become entirely useless, which wholly confined her to bed in a sitting posture; and the bones she rested on, having lost their solidity, were much spread. Also the ends of her finger and thumbs, by frequent endeavors to lift herself up for ease, became very broad and flat. Then she measured but 4 feet, though before this disease came on her she was about 5½ feet high, and well shaped.

This is the best information that could be obtained from her own mouth, and what was observed in the case before and at the first mentioned time, when she readily consented to the examination of her body, etc., after death.

From that time to her death, which happened July 6th, 1753, the chief thing she complained of, and what the people about her observed, was a gradual increase of difficulty of breathing, a wasting of flesh, a cessation of her menstruation for the last four months, a tendency in her legs to mortify, which had *long been anasarcous*, and excoriated almost all over; she retaining her senses perfectly to the last moment of her life, and dying without showing the least signs of the agonies of death.

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* A Remarkable Case of Fragility, Flexibility, and Dissolution of the Bones. By John Pringle, M. D., F. R. S. Philos. Trans., 1753, vol. xlviii, p. 297; Abridgment of Philos. Trans., vol. x, pp. 406–408.

Two days after death, her limbs being first well stretched out, she was exactly measured, and found wanting of her natural stature more than 2 feet and 2 inches. Then the thorax and abdomen were opened, the sternum being entirely removed, with part of the ribs, in order to gain at once a full view of these cavities, and discover how the viscera there contained had obstructed each other in their respective functions. The heart and lungs were sound but flaccid, and much confined in their motion, to which the enormous size of the liver contributed in some measure, extending quite across the abdomen, and bearing hard against the diaphragm. The lungs did not adhere to the pleura, nor was the liver scirrhous, but faulty only in bulk. The mesentery was sound, except only one large scirrhous gland on it. The pleura extremely small. Nothing else was found observable in these cavities.

The skull was not opened to examine the brain, as intended through want of time, the minister waiting at the church for interment, and the relatives becoming impatient, but the operators had no reason to suspect any defect there, from any previous complaint.

All her bones were more or less affected, and scarcely any would resist the knife. Those of the head, thorax, spine, and pelvis nearly to the same degree of softness. Those of the lower extremities much more dissolved than those of the upper, or of any other part. They were cut quite through their whole length without turning the edge of the knife, and much less resistance was found than firm muscular flesh would have made, being changed into a kind of parenchymatous substance, like the soft, dark colored liver, only meeting here and there with bony laminæ, thin as an egg-shell.

Those bones were most dissolved which in their natural state were most compact and contained most marrow in their cavities, and the heads of them were last dissolved.

This perhaps is the more worthy of observation, as it held good throughout, and looks as if the wonderful change they had undergone might be caused by the marrow having acquired a dissolving quality, for it was evident that the dissolution began within side, from the bony laminæ remaining here and there on the outside, and nowhere else, and the pain not being increased at first by external pressure.

The periosteum was thicker than ordinary—the cartilages rather thinner—but nowhere in a state of dissolution like the bones. The day after this examination some of the whole substance of the leg and thigh bones, that was entirely dissolved into a kind of pulp, was sent to an ingenious chemist, and by the experiments which he made he said he could discover neither acid nor alkali prevailing in it.

The disease in the following case, reported by Dr. J. W. Tenney, was preceded and accompanied by general weakness, emaciation, and copious discharges of urine, depositing an abundant light colored sediment, and by suppression of the menses. The patient referred the origin of the disorder to exposure to a cold atmosphere and standing in snow in thin shoes after fatigue and profuse perspiration.

CASE 771: Mrs. D. W., æt. 43, was the mother of five children. Her health had been but indifferent for the last fifteen months. She complained of general weakness, and especially in her lower limbs, emaciation, very copious discharges of urine depositing an abundant light colored sediment. She had experienced some colic pains, and in walking her gait was rolling, bringing the centre of the gravity at each step directly over the limb on which the weight of the body was thrown.

Her menstrual periods had ceased for about eighteen months. The origin of her disorder she had always supposed to have been exposure to a cold atmosphere and standing in snow in thin shoes after fatigue and profuse perspiration. After that period hitting the foot, in walking, against the slightest impediment, was sufficient to throw her down.

In November last, being troubled with neuralgic pains about the face and jaw, and supposing they might proceed from a decayed tooth in the under jaw, she requested that it might be extracted, but on attempting to raise the tooth with the forceps it was found necessary to desist and use rollers, as the bone seemed to bend though but slight force was used. A few days after it was found so difficult to extract the last tooth on the right side from the want of firmness in the bone and tension in the muscles that it was left in the socket. From this time the muscular strength of the patient failed fast, though her appetite remained tolerably good, and her stomach generally retained and digested her food, though it occasionally rejected all nourishment for a day or two. She became at length unable to support her weight or raise herself from the bed to which she was soon confined.

In the latter part of March her thigh-bone was found flexed at about a right angle near the centre. The patient was not sensible of it till it was accidentally discovered and supposed to be broken; but, upon bringing it into its natural position, no crepitation was perceived, and the extreme emaciation of the limb enabled us to satisfy ourselves that instead of being broken the limb was bent.

The outer limbs on examination, also, were found in the same condition, especially the long bones, which had so far lost their firmness as to be perfectly flexed from their position, which they would receive again by their elasticity.

The disease still continued its progress, the firmness of the bones diminishing till June 9th, when she expired. During this time the mental faculties remained bright, and with an unusually rapid flow of ideas; voice strong, pain not severe.

Autopsy 26 hours after death.—Corpse perfectly flexible; emaciation extreme; œdema of the lower limbs, and right arm, which had supervened during the last two or three days; fulness and hardness of the abdomen; thighs evidently shortened.

On cutting down upon the left femur, where the alteration of structure had first showed itself, no fracture was found, but the bone had doubled over on itself in such a manner that without altering the general direction of the limb it had shortened it about two inches.

About two inches below the lesser trochanter, the bone formed a right angle by bending inward, producing a prominence which might have been mistaken for the greater trochanter, while the limb was covered by the integuments. The neck of the bone was also bent, approximating the head of the bone to the greater trochanter. The bone was so soft in every part as to be easily pierced by a scalpel. The cartilage covering the articulating surface was in its natural state, but much harder than the bone. On laying open the medullary cavity, the medulla was found disorganized, very much resembling coagulated blood. This cavity was much larger than common, and the osseous substance much diminished. It was so thin and devoid of earthy matter as to be easily compressed by the fingers, so as almost to obliterate the internal cavity.

The external surface of the bone was less diseased, the osseous matter remaining being principally upon the outside. This bone was entirely detached and preserved.

The bones in the other parts of the body were examined, and found more or less in the same condition. The right humerus and femur seemed equally flexible, and had not retained their shape; the bones of the legs and forearms, though retaining their shape, could evidently be bent considerably and recover their position, though, if the strain was carried beyond a certain point, the texture was broken, and it would not recover its position, though a perfect fracture would not take place.

The phalanges of the fingers, the tarsal bones, the bones of the pelvis, the cranium, could all be pierced by a scalpel. The bones of the spine were so soft that the vertebræ could be cut into or their processes cut off with more facility than if they had been cartilage. The ribs of the right side had doubled over upon themselves, in a manner similar to the femur, so as to shorten them about an inch and a half, and materially diminish the capacity of that side of the thorax.

The muscular texture of the body was materially altered. It was pale, flabby, and so destitute of fibrin that it could be easily torn; even the tendinous portions of the muscles possessed little more strength than the loose cellular tissues of the body.

This appearance, in a greater or less degree, existed through the whole muscular tissue. The heart, for instance, was flabby, and could be easily cut with the finger nails, especially the right side. The uterus was in the same state, though not to the same degree.

The nerves retained their natural form, hardness and strength. The brain was not examined, as no symptoms during life indicated any disease of that organ. The lungs were healthy, though the common observation, that they were softer than natural, might be applied to all the internal organs. The omentum had a dirty appearance, and rough, gritty feel. Coats of the stomach healthy. Kidneys healthy.*

It is worthy of note, that in the preceding case the *muscles* were altered as well as the bones; and in this softening, and perhaps *fatty degeneration* of the muscles, we find additional and conclusive proof that the origin of the disease cannot be referred alone to the local changes in the bones.

If the disease was dependent upon an inflammation and alteration of the periosteum, we would not find this membrane so uniformly healthy and unaltered.

That the blood and blood-vessels are active in the changes of the bones, without any true inflammatory action, appears to be clearly shown by the fact that the wasting proceeds from within outwards, from the most vascular to the less vascular.

The following case of Mollities Ossium, reported by Thomas K. Chambers, M. D., is interesting, as affording a portrait, at an early stage of the disease, when it has rarely been a subject for observation, and as indicating that the degeneration of the bones was preceded by that of the muscles, and that the degeneration of the two tissues was dependent upon the same crasis.

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* Case of Mollities Ossium. By J. W. Tenney, M. D., of Webster, Mass. American Journal of the Medical Sciences, vol. xxvi, 1839, pp. 506-509.

It is also worthy of note, that the degeneration was least advanced in the external circumference of the bone, and perfect fat-vesicles were found in both bone and muscle.

CASE 772:* The case was that of a young woman, twenty-six years of age, admitted into St. Mary's Hospital, in March, 1853. She had never been able to follow any calling, on account of weak health. The principal features of the case, in the early stage, consisted in defective muscular power, the flesh of the body feeling exceedingly soft and flabby, the calf hanging down flaccid and baggy. During her residence at St. Mary's Hospital the bones of the back and limbs were examined several times, without any deviation from the natural state being discovered.

Spontaneous fracture, first of one femur and afterwards of the other, occurred at St. George's Hospital, and subsequently very marked changes in the osseous structures took place. Thus, in April, 1853, the right arm became painful to the touch, and paralytic; in May, the same misfortune happened to the left upper extremity; in June, the pelvic arch gave way; in July, the ribs on the right side fell in, and she began to suffer much from dyspnœa and cough; in August, the bones of both arms were quite soft; towards the end of October, the distortion of the lower parts of the trunk was so great that the fæces could not be expelled. She died in November.

The bones throughout the whole system were found soft and unresisting, and a sharp instrument could be readily passed through them. A section of the tibia was of the color of muscle, and presented to the knife scarcely more resistance than brain, its shape being retained by the aid of the tough periosteum.

The microscope exhibited the bone as consisting of large, fat vesicles, some containing a white, others a reddish oil. The parts next the periosteum, which felt gritty, presented, when examined under a quarter-inch glass, some islands of opaque bone, the bone corpuscles being indistinct, and the canaliculi not to be discovered.

The addition of hydrochloric acid caused a slight disengagement of gas.

The muscular fibre presented everywhere the characteristic degeneration.

In the preceding case, the muscular system, as well as the osseous, had undergone fatty degeneration.

Mr. Samuel Solly has described two interesting cases of Mollities Ossium, which agree in their general symptoms with those previously recorded.†

CASE 773: The first case described by Mr. Solly, was that of a young woman, aged twenty-nine, who, having enjoyed good health in early life, began to decline at nineteen, after an attack of scarlet fever. She suffered pains in the back, and passed urine with a whitish sediment, and her spine began to yield. The clavicle, which was fractured from a slight cause, never united again. The spine began to yield about the age of twenty-four or twenty-five; the patient began to stoop; and could not support herself in the upright position for any length of time. At this time she had paralysis of the right hand, which took place suddenly, and lasted about fourteen days.

A visit to Gravesend was proposed by her friends, but in crossing King William Street, she fell down and struck her knee against the curbstone. For this accident she was admitted as an out patient at the Western Dispensary, and continued so about six months. She derived benefit from bathing the knee with salt water, and the limb was restored sufficiently to enable her to walk. After this she kept a day school, but became nervous and desponding. Her friends remarked great difference in her manner, her disposition seemed changed from an open and amiable temper, to one of restlessness and suspicion. They became fearful that she was going out of her mind. She still, however, continued to conduct her school with her usual attention and care.

In May, 1839, being exposed to damp, she had an attack of acute rheumatism, when she was placed under the care of Mr. Dutton, of York Street, Bryanstone Square.

She was confined to her bed for six weeks, but during the course of her disease she complained very much of pain over the head, but particularly at the posterior part. She was occasionally violently delirious. At the approach of convalescence, mania set in, and during its existence she attempted to commit suicide.

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* Lancet, March 25, 1854. Ranking's Abstract, 1854, vol. i, p. 114.

† Medico-Chirurgical Transactions, vol. xxvii; 2d series, vol. ix, 1844, pp. 441–455. Medico-Chirurgical Review, April, 1845, Am. ed., pp. 448–450.

In August, 1839, she was removed to St. Luke's Hospital. At this period her general health was better than it had been for some time, and her appetite was good, but the catamenia had ceased for about three months. She was much deformed about the hips and shoulders, but not in her extremities.

Her mother reports that she was able to walk about six months after her admission into the hospital. Though suffering a good deal of pain, her mind was improving, and hopes were entertained of her speedy and total recovery, when she slipped down and suffered much at the time, but there was no fracture, and the injury was considered of so slight a nature that the surgeon of the institution was not consulted about it. But from this time the mother states she was not able to stand alone; she was carried, or pushed herself from place to place on her haunches, and, though she frequently screamed violently as in pain, she had no fit, nor did she lose her senses. She was not unruly, nor at all maniacal, but worked with her needle in her usual quiet manner. The progress of the disease affecting the condition of the lower extremities was evidently the sole cause of her inability to walk. The head was now first observed by her mother to be enlarged, and the eyes to project, caused no doubt by the thickening of the walls of the orbits. After remaining at St. Luke's thirteen months she was discharged incurable, but not paralytic; on this point, I took care to assure myself particularly. From this hospital she went to the Marylebone Infirmary, where she remained five weeks, from thence she was removed to the Islington Infirmary, where she remained two months, but Dr. Solly was not able to gain any particulars of importance regarding her condition in those institutions. She was then sent to the Lunatic Asylum at Hoxton for six weeks, was again received into the Islington Infirmary, from whence she was sent to Hanwell on the 11th of April, 1842.

At the time she was received into this asylum, she was much emaciated and enfeebled, with loss of power in her lower extremities, and two or three months before her death the bones of the extremities were observed to lose their natural direction and become curved. Subsequently fractures took place from the slightest causes. She suffered excruciating pain during the whole time she was in the asylum, which she referred to her bones; she did not suffer from spasm of the muscles, as many of these cases do, and the urine, during the whole time she was at Hanwell, was clear and natural. Her appetite was good, and all the functions duly performed, with the exception of the catamenia. Large doses of morphia and other sedatives were administered, to procure sleep and relieve pain. Her mental aberration was extremely slight. Her sufferings were terminated by death, on the 20th of October, 1842.

Post-mortem examination of the body, Hanwell, October 29th. Height, measured after death, four feet two inches, great emaciation. Head large in proportion to the size of the body; chest very much deformed, pinched up, and projecting anteriorly, very narrow from side to side; the ribs appeared widened, the pelvis extremely narrow, spine curved forward almost at a right angle in the upper dorsal and cervical regions. Both clavicles broken and bent at an acute angle; head of one humerus swollen, shaft of the left broken and bent; radius and ulna slightly swollen, the right radius broken; the lower extremities enlarged at the epiphyses; ossa femora on both sides broken, that on the right side in one place, that on the left in two; the fractured portions were held together by the periosteum, but there was no attempt at union, nor appearance of callus; tibia and fibula on both limbs bent; all the bones of the extremities could be fractured with the slighest force; by merely pressing them between the finger and thumb they gave way and cracked like a thin-shelled walnut. A longitudinal and transverse section of the long bones showed that the osseous structure of the bone was nearly absorbed, a mere shell being left. The interior was filled with a dark grumous matter, varying in color from that of dark blood to a reddish-light liver color. I could not detect any pus globules in it under the microscope. The bones of the vertebral column and ribs were similarly affected; cranium very much thickened and at least half an inch in diameter, so very soft as to be easily cut with a knife, and very vascular; the two tables were confounded, and the diploë obliterated. Thin slices of the cranium, under microscope, showed that a considerable alteration had taken place in its ultimate structure. The laminated structure of the outer and inner tables was extensively absorbed. The Haversian canals enormously dilated, and the osseous corpuscles diminished in quantity. Joints all healthy; cartilages perfectly natural. Weight of brain 2lbs. 5½ ozs.; arachnoid membrane milky and slightly thickened. The brain as well as the viscera of the chest and abdomen were perfectly healthy.

Chemical analysis of the bone by Dr. Leeson:—

Medulla.

Animal matter	24.78
Phosphate and carbonate of lime	1.83
Water	73.39
	100.00

Bone.

Animal matter	[illegible]
*Phosphate and carbonate of lime	[illegible]
Water	[illegible]
	100.00

In the preceding case the parents were healthy, both of whom were living at the time of the report; the mother aged 61, and the father 66. She lost one sister at the age of 21, of apoplexy, and a brother at the age of 38, of diseased liver, and some affection of the head. She enjoyed a good state of health up to the age of 16; was well developed and inclined to be corpulent; her mental faculties were remarkably acute, and at the early age of 16 she held her situation of governess in the family of a colonel in the army. It is worthy of note that the disease supervened after an attack of scarlet fever (soon after the age of 19), and that whilst in the earliest and most active stages, the urine contained a whitish sediment, in the latter stages, this excretion was clear.

In the second case reported by Mr. Solly, the urine was found on examination to contain a large quantity of phosphate of lime, between three and four times the quantity of healthy urine. The examination of the bones after death showed an excess of fatty matter, deficiency of the phosphates, and disproportion of the medullary cells to the substance of the bone. The left kidney contained a calculus, consisting solely of the phosphate of lime.

The following is the report of this case by Mr. Solly:

Case 774: The patient was a female, Sarah Newbury. I found her sitting up in bed; her countenance very cheerful, and excepting its extreme emaciation, not unhealthy. Her mind was very active, and all her answers to my questions clear and intelligent. She is thirty-one years of age, and has been married nine years and a half to a strong, healthy man in the police force; has never had any children. Her height, at the time of her marriage, was about five feet five inches and a half; her general figure slight. She was born in Dorsetshire, but was in service for fourteen years in London, as a housemaid, previous to her marriage. She was always able to do her work with ease. Her general health has been good, though, she says, she never was particularly strong or robust, and has been subject to sick headaches. She has been always regular at her monthly periods, but has suffered both before and after marriage from the white discharge. She considers that her health has been failing her for about three years, but more than that time. In May, 1840—that is, about three years and a half ago—she was seized with a violent pain in her back when she was stooping; and after that she had a strange sensation down her right leg, as if a pea was rolling down. She does not remember any other circumstance relating to her general health, until June, 1841, when she had rheumatic pains in her limbs, but never any true rheumatic fever, nor any swelling of the joints. From this time she constantly suffered from what she considered rheumatic pains, and was so feeble on her feet that in February, 1842, she had a fall—which, in fact, she says she had been expecting every day—when her left thigh was much bruised; but she did not feel anything give way; but in consequence of the bruises she was confined to her room. After this she occasionally suffered a great deal of pain in her limbs, which, she says, seemed to be in her bones; and she was not able to walk unless on her left leg, and with assistance, dragging the right after her. In the April following—that is, about two months after the accident—when her husband was lifting her from the fireplace to carry her to bed, she says she suddenly felt the most excruciating pain, just as if her thigh were being broken in a thousand pieces; and her husband told me that he felt her thighs give away, and that they were suddenly drawn up; and from this time she has been entirely confined to her bed. She says that the muscles of her arms were now painful and swollen, but by rubbing them with oils she relieved them.

Her present condition, October 2, 1843: I do not perceive anything abnormal in the appearance of the bones of the head or face. The countenance is emaciated. There is a lateral curvature of the spine; in the dorsal region the convexity is to the right, the concavity to the left. In the centre of the lumbar region the spine curves forwards; the inferior vertebræ, with the upper portion of the sacrum, projecting backwards; the lower portion, with the coccyx, turns suddenly forwards, forming almost an acute angle. On the left side the ribs project backwards to their anatomical angles; from that point they are bent directly forwards, forming an acute angle, which projects posteriorly, looking at first sight like the spinous processes of the vertebræ in a very thin person; the side of the thorax from the angles being flattened or slightly concave, and the lateral diameter of the chest much diminished in consequence. This latter deformity has evidently been produced by her lying altogether on the left side, either on a pillow or on her arm. The clavicles have both been fractured and reunited, and are bent at a right angle in the centre. The bones of the arm and hand are all natural. I could not examine very accurately the ilia, but I perceived that they were evidently folded inwards. Both thigh bones are broken. The lower portion of the left is twisted around, so that the patella faces inwards. The right thigh is bent completely at an acute angle in the centre. The lower portion turned outwards. The tibia and fibula of both legs and the rest of the bones, appear quite healthy.

I now made her an out-patient of St. Thomas's Hospital, for she refused to come into the house, and I prescribed for her a simple bitter infusion, as her appetite was failing. This, however, she refused to take; and I received a letter from her a few days afterwards forbidding my visiting her any more. I mention this to account for my losing sight of the case until the 12th of April, 1844, when her husband called on me to request that I would admit her into the hospital, which I did on the following Tuesday.

April 15, 1844. Present condition: the disease had been progressing, but not very rapidly. The countenance is rather more emaciated, and both maxillæ appear narrowed from side to side. The alveolar cavities of the superior incisor teeth are softened, allowing them to protrude forwards, and she is not able to bite with them. The right humerus has given way in the centre, and the arm lies perfectly useless in the bed. It cannot be moved without giving her great pain. The radius and ulna are not apparently altered, but the metacarpal bones and phalanges are quite soft. The whole hand is rather swollen and puffy, and its natural appearance changed.

The thorax is much narrower. On the left side there is a depression about the circumference of an orange, the centre of which is occupied by the fifth rib—about an inch and a half from its junction with its cartilage; in this depression the action of the heart can be distinctly seen and felt. Its sounds are natural. I think that the spine is rather more curved than when I saw it in October. I do not perceive any particular alteration in the lower extremities, though it is most probable that the right thigh-bone has become more flexible, as previous to her removal to the hospital the foot was drawn completely over the head—the same position as represented in the case of Madame Supiot. She complains of the heat, and likes to have very little clothing, as much produces a sense of suffocation; she perspires very very freely. I inquired of the sister whether she ever shows any particular desire for salt, as has occurred in similar cases, but I learn that she does not.

April 15th. On her admission she was allowed wine and arrow-root, a mutton chop, and a pint of porter daily, and was also ordered the infusion of orange-peel, a rhubarb pill when necessary, and an opiate at night if required.

20th. On this day she died suddenly, without any circumstance having occurred during her stay in the hospital that I considered worthy of note, as illustrating the pathology of the case. I procured some of her urine, which was found on examination to contain a large quantity of phosphate of lime. Mr. Heisch, who examined it, says, "between three and four times the quantity of healthy urine."

She was too suspicious and irritable to let me venture to take any blood, even in the smallest quantity, during her life. As, however, it was perfectly liquid after death, I had no trouble in procuring some for examination under the microscope, but it did not exhibit anything unnatural. Dr. Rees kindly analyzed a portion of it, but he informs me he detected nothing abnormal The immediate cause of her death appears to have been asphyxia. Mr. B. Travers saw her in her last moments, and he says the laboring condition of the respiratory organs was very painful to witness. She took a little wine about twenty minutes past six, when her sister noticed some difficulty of breathing, and the patient stated she thought she was sinking; she then became purple, and struggled some little time before she expired.

21st. *Post-mortem examination fifteen hours after death.*—Thermometer 60° Fahr. 10 A. M. General appearance of the body: great emaciation; integuments of the head and face and upper part of the neck, livid. As regards the state of the limbs, in addition to what has been reported during life, it was found that the radius and ulna on the right side had given way above the middle, and that the metacarpal bones and phalanges of the same hand were all flexible. On the left side all the bones of the upper extremity appeared in their natural condition inasmuch as their form was not altered; but in testing their strength they yielded to a very slight force, and they might be bent in almost any direction, the laminated shell breaking off short. In the lower extremities the tibia and fibula of the left side yielded about two inches from the knee-joint; below this point they were firm. Those on the right side resisted pressure, and though they were not so heavy or hard as in a healthy subject, the disease had evidently made very little if any progress in them.

Head.—Calvarium very soft; dura mater excessively adherent, and, when torn off, innumerable vessels poured forth their blood in large quantity. The under surface of the calvarium was more vascular than I scarcely ever remember to have seen it, and all the vessels were full of dark blood.

Some serous effusion within the cavity of the arachnoid.

The brain was healthy throughout; the hemispherical ganglion was natural in appearance, neither pale nor dark-colored.

Thorax:—This cavity was so much diminished in its transverse lateral diameter that a skewer passed from one side to the other, through the intercostal space between the fifth and sixth ribs, gave only four inches. On the right side there was a general depression of all the ribs; but on the left, the fourth, fifth, and sixth ribs were, especially, bent inwards, immediately over the heart. It was in this hollow that the heart could be seen pulsating during life. The serous membranes of the heart and lungs were all healthy.

The right lung was compressed to about one-fourth of its natural size. presenting the appearance which it does when hydrothorax is present, for it was excessively congested, and almost impervious to air; very much consolidated, but not from inflammatory effusion. The left lung was also diminished in size, but to not more than half the extent of the right; it was likewise much congested. The heart was natural and full of blood.

Abdomen:—Intestines tympanitic, venous congestion of the liver; spleen small, and rather sanguine; pancreas healthy.

The lacteals were distended with chyle, which presented the ordinary granular appearance of this fluid.

The thoracic duct was almost empty; the fluid which it contained consisted of granular matter similar to that of the lacteals, and also some chyle-globules, which were of the usual character. Different parts of the sympathetic nerve were examined, but they presented nothing unusual in their appearance.

The left kidney contained a calculus of considerable size, which, on examination, was found to consist solely of phosphate of lime.

Female organs healthy.

Section of the bones:—The bones of the skull were not thickened; they were very vascular and soft, though by no means so much so as in the first case; they contained, in small quantity, the same kind of red substance which was observed in the former case. Their sections exhibited a similar open reticulated texture as that in the skull in the first patient.

A section of the radius exhibited very beautifully the progress of this disease; at both extremities there was merely an unnatural degree of vascularity, though the vessels forming it were not very red. The head of the bone was more injected than the lower end of it; at the lower part of the upper third, the cancellated structure had been partially absorbed, and its place occupied by the red grumous matter. So little of the earthy matter had been removed, that the bone retained nearly all its natural firmness.

Sections: *The Sternum.*—Externally this bone did not seem much altered in firmness; it was not at all altered in form. But internally the disease had advanced rapidly, absorbtion of the earthy matter having taken place in patches, and the red substance occupied its place. The appearance it exhibited has been very beautifully represented by Mr. Kearny.

Ribs.—It was evident, from the external form of these bones, that they were extensively diseased. Only one was divided, which was interesting, from its showing the disease in various stages of development.

Spine.—The same appearance in these bones as in the rest.

Thigh-bones.—The right one alone was divided, and in this the disease had made such progress, in the centre of it, that the whole of the osseous matter had been removed, and nothing but periosteum and membranous matter left; while at the upper part of the lower third of the bone, the red matter was abundant, exhibiting various hues, from a deep Modena red, to a bright scarlet crimson, the osseous laminated shell remaining, but almost as thin as a wafer; then towards the condyles a portion of the bone was nearly of its natural color, only yellower and softer, from an abundance of fatty deposit. The extremity of the bone, to the extent of about one-third of an inch, was of a bright red color, contrasting beautifully with the clear, healthy color of the cartilage. This redness was evidently the effect of inflammatory injection of the vessels.

A section of the head, neck, and upper third exhibited, to a certain extent, the same appearance as a corresponding section in the case of Caroline Stephens. There was, however, a difference of considerable interest, in a pathological point of view, in illustration of the course of the disease.

The cells which contained the red matter were distinct throughout the section, but in some of them this matter had become entirely absorbed; a transparent serum occupied its place. The head of the bone was completely hollow, and filled with serum; there were two other smaller cavities at the lower portion of this part of the bone, filled in the same manner.

The red matter I examined carefully under the microscope, with my friend, Mr. Birkettt, of Guy's, who has drawn up the following report of his observation:

'From the cellular spaces of the cranial bones, a soft, reddish, gelatinous solid could be removed. It mingled readily with water, rendering the fluid turbid. In it I could see cells with nuclei of two kinds. The first round, and clearly exhibiting a nucleus and nucleolus;

they were, however, few in number, and certainly could not be said to compose the mass of the solid, which apparently contained a delicate fibre of fatty matter. The second kind were very clear, their edge being remarkably distinct, and the clear oval outline inclosing *one* bright *central* nucleus, *rarely two, never more.* There was a tendency to elongate into the caudate cells, but this appearance was very rare. Many other cells of irregular figure and shape, some with, others without central nuclei, existed.

"Large cavities existed in the body of the vertebræ, filled with a dull, oily, reddish matter, and which contained a great number of cells having an irregular outline, and some a very distinct nucleus, rendered more distinct by dilute acetic acid. I could find no distinctly caudate cell, as in the cranial bones, and the identity of these cells with pus-globules, (for they appeared larger than pus-globules commonly are), or the commonly called nucleated cells of malignant disease, was difficult to determine; in the femur I saw nothing but fat cells and blood-disks."

"The red colored matter in the bones," says Mr. G. Rainey, of St. Thomas' Hospital, who also examined it, "consists of a multitude of roundish bodies, almost the size of the blood corpuscles, each of the bodies being filled with a minutely granular substance. Besides these bodies, it contained also fat globules, but no regular fat vesicles, and it appeared to be wholly destitute of any fibrous or cellular structure."

Mr. Simon, of King's College, examined portions of the bones, and thus expressed himself in a note to me on this subject: "My examination was not at all satisfactory as to the ultimate nature of the disease. There was great excess of the natural fatty matter, and disproportion of the medullary cells to the substance of the bone; in parts there was apparently extravasation of blood, which may have arisen from violence. I was unable to discover any new cell formation, at least any mature one; cytoblasts were exceedingly plentiful, so as to suggest the probability that some such formation was in progress, but nothing further, with the exception of some two or three apparently detached young fat cells. Decidedly there was no show of growing cartilage."

After a careful consideration of all the facts, and especially by comparing the appearances after death with the symptoms during life, of this awful disease, Mr. Solly was led to believe that it is of an inflammatory character; that it commences with a morbid action of the blood-vessels, which give rise to that severe pain in the limbs invariably attendant on this disease, but more especially in its commencement, and exhibits itself after death, by an arterial redness of the parts. The absorbent vessels are at the same time unnaturally excited, and the earthy matter of the bone is absorbed and thrown out by the kidneys in the urine, which excretion is sometimes so abundant, as we have seen in the last case, that it clogs up the calices and pelvis of the kidney and forms there a solid calculus.

The place of the phosphate of lime in the bones, is supplied by that morbid secretion of red, grumous matter, which has been so universally found in this disease, and which was so abundant in both the cases just related. The microscopical examination of this matter confirmed Mr. Solly's impression, that it is an adventitious, morbid product, and not simply the fatty matter of the bone, altered by the effusion of blood into it.

Mr Solly concluded that the enormous hypertrophy of the bones of the skull, in his first case, as also in that of Madam Supiot, demonstrated that it is an active disease, and not a mere atrophy. Indeed, he supposed that the inordinate vascularity of the bones of the skull, though unaccompanied by increase of thickness, in his second case, proves nearly as much; and he had no doubt but that if this patient had not died so suddenly, but had survived another twelvemonth, a similar thickening of the skull would have taken place. It is interesting, in relation to the pathology of the brain, to observe the effect of this disease on its solid covering in the case of Stephens, where the intellect was deranged. Whereas, in the latter instance recorded by Solly, the mind remained perfect to the last, where the skull was not altered in it dimensions.

Dr. Thomas Blizard Curling has recorded the following case of Mollities Ossium, under the head of Eccentric Atrophy of Bone:

CASE 775:[*] Catharine Burne, aged 72, was brought to the London Hospital, from the workhouse at Poplar, February 18th, 1833, in consequence of a fracture of the right femur,

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[*] Observations on Some of the Forms of Atrophy of Bone. By Thomas Blizard Curling; Medico-Chirurgical Transactions, 1836, vol. xx. pp. 356-373.

She had been an inmate there since the 18th of September, 1827, and had been bed-ridden for nearly four years, on account of paralysis of the lower extremities. The hip and knee-joints had been in a state of flexion so long that it was impossible to straighten them, and for some years she had experienced great pains in the knees and thighs. She had been subject to hysteric fits, also to a slight cough, and ever since her last confinement had been troubled with incontinence of urine, in which secretion, nothing peculiar had at any time been remarked. Her appetite had always been good. On being turned in bed by a nurse, on the morning of the day that she was sent to the hospital, her right thigh was suddenly fractured.

About a fortnight after her admission, whilst being moved in bed, her right humerus was also broken. The arm was placed in splints, but from this time she gradually sank, and died on the 19th of March. On examining the body, the lungs, abdominal viscera, and mesenteric glands were found healthy, but the heart was rather flabby. There was considerable calcareous deposit in the lumbar and iliac glands, and a fistulous communication between the vagina and bladder. Between three and four ounces of serum escaped from the cavity of the arachnoid; and between the layers of that part and the dura-mater covering the upper surface of the brain, some tubercles were found. All the articulations were in a healthy state. The periosteum was everywhere normal, except over the trochanters, where it was entirely detached, owing, most probably, to inflammation induced by the pressure to which they had been so long subjected. The bones of the skull and pelvis might be cut with a strong knife, but the ribs and vertebræ were only slightly affected, being scarcely less firm than usual. The femur consisted of a thin shell of bone filled with medulla, its cellular structure being entirely obliterated, except in the head of the bone and at the trochanters, where there was a slight appearance of cancelli greatly enlarged. Some dark spots were observed at different parts of the interior, which were found to be produced by extravasated blood. The fractured extremities of the right thigh bone had a slight ligamentous connection. The tibia also consisted of a mere shell of bone, elastic, and yielding under the finger like a thin piece of ivory, the cancelli being removed, and the interior likewise filled with medulla. Although only a thin lamina of bone remained at their extremities for the attachment of the articulating cartilage, that structure was not in the slightest degree affected. The tarsal and metatarsal bones and the bones of the phalanges of the toes were much less firm than in the natural state, and their cellular texture enlarged. The humerus was firmer than the thigh bone; it did not yield to pressure, and in order to make a section of it, the use of a saw was necessary: whereas, all the bones of the lower extremities could be readily cut with a knife. The walls, however, of the bones of the superior extremities were preternaturally thin, and their medullary cavities evidenty enlarged. Upon making section of the different bones, patches of a light red color were remarked at different parts, and these, upon inspection with a magnifier, were found to arise from the minute vessels of the medullary membrane being highly injected with red blood. The oily substance with which the bones were filled, closely resembled the medulla of an old subject, and several of the bones having been placed for some months in water to mascerate, it was converted into adipocire, a beautiful specimen of which was afforded by a section of the humerus

It is to be regretted that it was impossible to obtain a fuller account of her state of health, and of the different secretions at an earlier period of the disease.

From a review of all the circumstances connected with this and other forms of atrophy of bone, Mr. Curling concludes that the wasting of the osseous tissue is here the result of defective nutrition, and not of increased activity in absorption, and resembles the decay which occurs in advancing years; in both, the lesion is more remarkable in females than in males, and in both, the atrophy is chiefly eccentric, and the interior of the bones is filled with an increase in the medulla.

If it were owing to the latter action, continues Mr. Curling, we should expect that the wasting process would go on most rapidly in the cancellous and vascular parts of bone, whereas we find that the denser parts, and those of inferior vascularity are most rapidly removed.

Again, the disease appears first in the bones of the lower extremities, for the same reason, probably, that all morbid changes consequent upon defective nutrition, or a feeble circulation, commence oftener in the depending parts.

According to Mr. Curling, the various apearances presented by the medulla, which is sometimes described as vitiated, or as being of a reddish color, and resembling flesh, liver or tallow, is owing to slight modifications in the secretion, together with some degree of increased vascularity in the medullary membrane, or to the medulla being mixed up with blood accidentally effused, as would readily happen if there was any distortion. Mr. Curling was satisfied, from his examination of the bones in this disease, that the matter with which the bones are filled is nothing else than an increase of the true medulla, somewhat altered in appearance, but very slightly in its essential characters.

M. Saillant, in a case which he brought before the Faculty of Physic in Paris, in 1792, calls the disease medullary gout. Indeed, rheumatism has frequently been considered as giving rise to it. All the cases have been accompanied with severe pains in the limbs, and many of them preceded by severe rheumatic attacks. M. Kilian asserts that the most common exciting cause is violent cold, produced by getting wet through, especially during menstruation, or the presence of the lochia; he also enumerates sudden fright, grief, misery and poverty. The most severe cases, according to this author, occurred in women confined in damp prisons.

Mr. Howship remarks in reference to this disease, that it is the "effect of a morbid action in the capillary's arteries upon the medullary membranes within the bone; and most probably the progressive absorption of the bone itself was merely one of the consequences of the long continuance of the malady."*

If the view expressed by Mr. Solly be true, that Mollities Ossium is of an inflammatory character, it is evident, however, that the altered state of the osseous tissue is essentially different from that which commonly occurs in inflamed bones. Thus, in inflammation of the bones, the periosteum is always more or less involved, and the appearance of extravasation of blood in Mollities Ossium may arise, in part at least, from the fractures and distortions of the bones.

It is well known that in bad cases of scurvy the bones occasionally become so brittle that they are broken by the slightest causes, and do not unite again by callus, as long as the scorbutic state continues. And in some cases of scurvy the callus of old fractures is destroyed after it had been formed. Boyer, in his *Lectures on the Diseases of the Bones*, states, that if the bones of a scorbutic person be boiled, the periosteum separates very soon, lamellæ scale off, and, in some cases, the bone dissolves entirely. They also fall into powder if kept for some time, but particularly if exposed alternately to heat and moisture.

It is also well established that in this peculiar state of the system induced by sameness of diet, and salt food, the smallest injuries, and even vaccination, may be attended with the most extensive and foul sloughing and gangrenous ulcers, involving in one common destruction integuments, muscles, nerves, vessels and bones.

The origin of this state of the system is clearly referable primarily to changes induced in the blood, and secondarily to the perversion of nutrition and the degeneration of the solids.

In like manner it would appear to be more philosophical to refer that peculiar state called mollities ossium, to derangement of the blood and nutritive processes in its origin, rather than to a peculiar disease of the bones, originating solely in the osseous system. In many of the cases there would even appear to be some connection between this disease and scurvy. The case related by Mr. Gooch and Dr. Pringle, to the Royal Society in 1753, had symptoms of scurvy, and bled much at the gums. Madame Supiot, for two years before the disease commenced, had been in the habit of eating a pound or a pound and a half of common salt in the course of a week, without any vehicle. In this case the gums swelled much, and were separated from the teeth, allowing them to fall out. In the case of Sarah Newbury, there was no bleeding of the gum, but the teeth became loose in consequence of the softening of the maxillæ.

Again, the disease is frequently attended with symptoms of a remarkable kind, which can only be referred to changes in the blood and vascular system. Thus, in the case of Madame Supiot, it was noticed that, when the bones were softening, the urine deposited a white, chalky sediment, which came away after her pains, and ceased towards the termination of this protracted case, when scarcely a bone remained for the disease to prey upon. Both the urine and saliva stained the linen black. In the case of James Stephenson, recorded by H. Thompson in his *Medical Observations and Inquiries* (vol. v), for the first two years of the disease, the urine deposited a whitish sediment, which. upon evaporation, became like mortar, and the patient, a shoemaker, at Wapping, voided three or four small jagged stones some time after a complaint in his loins.

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* Edinburg Medico-Chirurgical Transactions, vol. ii.

In the case related by M. Saillant, the urine was high colored, turbid and fetid, and the hands and feet were constantly covered with an unctuous humor, which, as it dried, thickened into scabs. In the case reported by Mr. Howship, the perspiration was abundant, and possessed an unusual fetid odor. In another case reported by M. Saillant there were copious sweats, and an almost incessant salivation.

All these circumstances seem to indicate that the blood was loaded with something which was necessary to be eliminated by the skin, kidneys and salivary glands.

These symptoms sustain the view advocated by Meischer and others, that the earthy parts of the bone, after being absorbed, are excreted with the urine, in which they deposit a white sediment, cretaceous and soluble in acids, and that this solution of the earthy parts of the bones is dependent on an acid diathesis, as exhibited in acid eructations, vomiting and sweats.

CHAPTER XXI.

RELATIONS OF MOLLITIES OSSIUM TO FRAGILITAS OSSIUM.

Case of Marshal Lewis, observed by the author—Illustration of the hereditary brittleness of bones, recorded by Dr. Paull, of London—There is a state of the osseous system, correctly indicated by the term Fragilitas Ossium, which cannot be referred to the syphilitic, scrofulous or cancerous cachexia, and which exists with health.

WHILST it is true that the bones become fragile in certain stages of mollities ossium; and whilst a certain degree of fragilitas ossium occurs in old age, and in some cases in the latter stages of syphilis, and in certain cases of cancer, where the whole mass of fluids is infected, and the virus attacks the bones, destroys the vital parts, and renders them brittle—at the same time there is a true fragilitas ossium, distinct from these diseases and from mollities ossium.

I have enjoyed the rare opportunity of seeing these two diseases at the same time and in the same place, and of comparing the two diseased actions.

The following case of fragilitas ossium came under my observation at Nashville, just at the time when I was treating the case of Miss Raney Drucilla Bozel.

CASE 776: Marshall Lewis; dark mulatto; age 24; Nashville, Tennessee, 1868. His father and mother stated that, when about two years of age, Marshall was attacked with typhoid fever in the fall of the year, during an epidemic of this disease which prevailed in the neighborhood. The case was somewhat protracted, and the attending physician administered calomel daily in small doses. The child recovered entirely, and enjoyed good health. When three years of age, Marshall accidentally fell out of the door (the house being built on the ground and low,) and caught on his hands. His legs striking the door-sill, were fractured short off about the middle. The attending physician set the legs in pasteboard splints, and directed that they should be wet with vinegar, which caused the splints to slip off, and the bones of both legs united irregularly. Since this time he has had numerous fractures, numbering in all near *fifty*. The slightest fall produces fractures of the leg or thigh-bones. Several fractures have occurred during play.

At the present time Marshall enjoys excellent health; has never been sick, with the exception of the attack of typhoid fever. Weight, 150 pounds; has weighed near 170 pounds, but at that time was more active in his habits (followed his trade of boot-making) than at the present time, when he leads a sedentary life, studying his books diligently and endeavoring to acquire an education.

Chest large, full, and well developed, with powerful muscles. Height of Marshall, 4 feet 4¾ inches. Breadth of shoulders, across from the outer border of one humerus to the outer border of the other, 18 inches. Circumference of chest, 40 inches. The well-formed chest is supplied with powerful pectoral muscles, and long, muscular, strong arms. Length of body from crest of ileum to top of head, 26 inches; from crest of ileum to bottom of foot, 26¾ inches. The latter measurement is not one-half what it should be, owing to the numerous fractures and bending of the legs and thighs. Arms powerful and long; length of arm from shoulder to end of wrist, 32 inches. Hands large and powerful. Right forearm has been broken near the wrist-joint, and in the elbow-joint, which is consideraby deformed. The left fore-arm has been fractured twice.

The great size of the muscles of the arms and chest appears to be the result of the constant use of crutches in walking—cannot walk without crutches.

The thighs have been fractured so often, that they are bent like bows. The leg bones were in early childhood broken about the middle, and the upper fragments projected anteriorly, forming almost right angles with the lower fragments; and the ends of the projecting bones are covered with a hard, thick, shining, horn-like skin, although they do not strike the ground in walking. The length of the right thigh is only 15 inches, and that of the right leg about 16 inches. Feet quite small; the patient wears No. 2 shoes. Length of foot, 8 inches; breadth across sole of foot, 3¼ inches. Thighs, although misshapen and bent like a bow, with large masses of callus thrown out along the femur, are still large and muscular, whilst the muscles of the legs are greatly wasted.

The parents were disposed to regard the brittleness of the bones as due to the typhoid fever and calomel, but nearly one entire year had been passed in good health before the appearance of the fragilitas ossium; and in addition to this, in reply to various inquiries relating to constitutional and family diseases and tendencies, I was informed that the niece of Marshall's father has had numerous fractures, being afflicted in a similar manner with Marshall, although she has borne children and is apparently stout and healthy.

Mother of Marshall, a powerful, hardy, black negro woman, age 52, has had twelve children, all of whom were vigorous and strong. Those of her grown children whom I have seen are large and healthy. Father of Marshall, a stout, light mulatto man, 52 years of age.

The points of interest presented by this case, as distinguishing it from mollities ossium, were:

1st. The fractures were attended with little or no pain, and healed rapidly by the formation of callus.

2d. The general health of Marshall Lewis appeared to be perfect, and there were no marks of cachexia or of a scrofulous or syphilitic taint.

3d. The appearance of the same brittle state of the bones in a niece of his father's indicated a constitutional origin of the disease, or rather that the brittleness of the bones was hereditary.

Dr. Paull, of London, has recorded a striking illustration of the hereditary brittleness of bones and their repeated fracture in members of the same family. All the members of a family residing in the commune of Offenbach have had fractures; three of them have each had two fractures; another three; one has even had as many as five fractures of one or the other extremity; and to produce these injuries no considerable violence was in general requisite. The father and grandfather before them had fractures of the limbs. Dr. Paull, moreover, described this family as a very healthy one, without any scrofulous or other perceptible taint. It is remarkable that not one of them suffered a fracture before the age of eight, so that one might suppose that this peculiar fragility of the osseous matter was developed only towards the age of puberty. Dr. Paull conceived that the condition of this fragility consisted in some change of the chemical constituents of the bones in their relations to each other.

It has been frequently observed that men addicted to the use of brandy often experience fractures (in consequence of a degree of brittleness induced in the bones,) which require a long course of treatment to insure their consolidation. Dr. Paull met with this fragility of the bones in a subject of this kind, a man 54 years of age, who hung himself at Yorchlengen; the ribs, particularly, snapped like glass, and a very moderate force sufficed to fracture the long bones. But if fractures in these old drunkards are cured only very slowly, precisely the contrary was the case in the family above mentioned; for in every instance that occurred in it the fracture was very speedily consolidated, so that generally the callus was perfectly firm at the end of three weeks. When the same bone has been broken a second time, it has never occurred at the seat of the callus.

We are justified by these cases in assuming the position that there is a state of the osseous system correctly indicated by the term fragilitas ossium, which cannot be referred to the syphilitic, scrofulous, or cancerous cachexia, and which exists with perfect health, and the repeated fractures are rapidly united by callus.

Case 777: A remarkable case of fragility of the bones, accompanied by caries and ulceration, with profuse suppuration, came under my notice in the female wards of the Charity Hospital, during the summer of 1869. The disease, which occurred in a virgin adult female, twenty-eight years of age, was referred to the action of inherited and constitutional syphilis.

This case was so remarkable, that, I obtained the body, after death, which apparently was caused by the profuse suppuration from the numerous open ulcers, communicating with the fractured extremities of the carious bones, and prepared the skeleton, which is preserved in the pathological collection of my Practical Laboratory of Pathological Chemistry and Toxicology. The intellect was clear, and the appetite and digestion good up to the time of death.

The following is an outline of this singular case:

I observed this unfortunate woman in the Charity Hospital, only a day or two before her death. At the time of my observation, she appeared to be exceedingly feeble, and was a mass of offensive, running sores. I obtained the body after death, and had the skeleton carefully prepared. The hymen was perfect, and the disease appeared to have been derived from inheritance, and to have manifested itself in early childhood. The feet are very small—not much larger than those of a child four years old, and appear never to have been used in walking. All the long bones of the body were more or less carious, and in almost every case fractured, or, rather, ulcerated through at one or more places. The pelvic bones were carious, and the os-sacrum a mere shell. The vertebræ were all carious. The upper jaw contained one small tooth, and the lower jaw three teeth. The alveolæ was completely absorbed. The outer and inner tables of the skull were perforated in several different places. The lower jaw, on the right side, was eroded through. The position of these fractures or erosions, were marked during life, by open running sores.

It is impossible, with the pen, to portray, adequately, the terrible condition of this unfortunate female, whose bones literally rotted piece-meal by piece-meal during life. And the best description which we can give of the skeleton is to say that the bones of the feet, ankle, the os calis, were carious; the tibia and fibula, the femur, the pelvic bones, the os-sacrum, the radius and ulna, the humerus, the scapulæ and sternum, the lower jaw and the cranium were all eroded through in various places.

The bones are diminished in specific gravity, and present a light, spongy appearance, as if they had been acted upon by corrosive fluids, in and around the vascular canals. The bones resemble more nearly those of cancerous growths, and of joints affected by syphilitic and rheumatic inflammation. In a case of ankylosis of the knee-joint, the effect of syphilitic and rheumatic inflammation, occuring in a prostitute, and in which the patella is consolidated with the femur, the tibia and fibula consolidated with each other, and the articulating surface of the tibia, with that of the femur, the bones are light and spongy, as in the preceding case, and are of far less relative weight, density and tenacity, than the bones of an ankylosis of the knee-joints from mechanical injury. In the ankylosis resulting from mechanical injury, although the patella is firmly consolidated with the femur, and the tibia and fibula firmly consolidated with each other and the femur, the bones present the characters and density of healthy bone.

The bones from the woman supposed to have suffered from inherited syphilis were carefully compared with necrosed bones, resulting from mechanical injuries; and it appeared that the former were lighter and more spongy than the latter. Thus the sequestrum from the thigh of a confederate soldier was employed as a good object for an intelligent comparison.

Case 778: The following is an outline of this case:

Charles R. Barker, C. S. vols. 7th Reg. La. Vols.; height, five feet, eight inches; weight, in health, 154 lbs; brown hair and eyes; nervous, sanguine temperament. Wounded in right leg at first battle of Manassas, 21st July, 1861. Minie ball struck the lower portion of the right femur, about two inches above the inferior termination, the knee-joint. The bone was not fractured; the ball simply buried itself in the femur. The force of the ball must have been greatly spent, otherwise it would have passed entirely through the bone. The wound inflamed, and assumed an unhealthy appearance, and twenty days after the reception of the wound, the thigh was amputated near the middle, or about eight and a half inches from the trochanter major, in the general hospital at Culpepper Court House, Va. After the operation, the wound did not heal, and the stump assumed an unhealthy, suppurating state. The patient was confined to his bed for more than four months, during which time, there was but little progress in the healing of the wound, the discharge continuing, although there was partial union of the flaps. At the end of this period, the patient attempted to walk on crutches, and on the 20th of February, 1862, whilst the snow covered the ground, went out. This caused the stump to inflame, an accumulation of pus took place around the bone, and the flaps were opened. At this time, large quantities of offensive pus were discharged. The patient was so much reduced by this condition of the stump, that he was compelled to remain in bed until the first of June. After this date, the wound slowly improved and considerable portions of the flaps united. In December, the patient was able to travel to Georgia, and enter the general hospital at Augusta, January 10th, 1863, and at this time came under my treatment. After careful examination, the bone was found to be extensively diseased; and the discharge from several fistulous openings was profuse and fœtid. At the time that this patient entered the general hospital, he was in a most weak and feeble condition, and suffered from hectic fever consequent upon the condition of the stump. The pulse was rapid and feeble, and the complexion dusky and unhealthy. The sloughing went on rapidly, until the bone of the thigh was exposed and denuded. The patient was placed upon the Tartrate of Iron and Potassa, Sulphate of Quinia, generous diet, and stimulants and opiates. Under this treatment, the patient gathered sufficient strength to resume the use of his crutches. After some imprudence, the patient was again prostrated. The bone, which was examined daily, finally protruded a little and gave unmistakable evidence that it was detached. On the 24th of May, I placed the patient under the influence of chloroform, and abstracted the bone, seven and a half inches in length, and extending to the trochanter. I lost sight of this patient, until I found him in the Charity Hospital this winter, just after I had exhibited the diseased bone to the medical class. The limb healed up entirely, and the patient wears a stump. The periosteum of the bone threw out another bone, and the thigh feels as if it had a large bone.

The bones affected with syphilis, were in striking contrast to the dense, strong bones of a man who had suffered with rickets and caries of the vertebræ, and who was suddenly killed.

Specimens illustrating these various points, are preserved in my Practical Labratory.

The following case illustrated the ravages caused by Scrofula, and the wonderful resources of nature in the endurance of disease. I observed this case in Nashville, Tennessee, and at my request, Dr. John W. Morton, Jr., drew up a careful report, and also caused the execution of photographs.

CASE 779: *Illustrating extensive Caries of the Vertebræ and Ribs, and Perforation of the Lungs.*

Berry Subbs (colored); age 20 years. From birth up to 1861, was stout and healthy, and worked as a blacksmith. At this time suffered with swelling and inflammation of the Lymphatic Glands of the neck. In 1863, joined the Federal Army, but returned to his home in Alexandria, Tennessee, in 1864, in feeble health, with extensive ulcerations on the neck and chest. Came to Nashville, 1866. I saw him for the first time, July 15th, 1867. The following was his condition: Black skin, woolly head, with thick projecting lips; large, swollen abdomen; heads of long bones enlarged; knee and ankle-joints swollen; hands and feet very large; ill-formed. Appetite irregular, sometimes deficient, at other times ravenous. Craves fruit and vegetables. Speaks with great difficulty; voice feeble and irregular; air issues from an ulcer which penetrates through the 3d and 4th ribs of the left side, and communicates with the lung. The patient breathes through this opening as well as through the mouth. He is able to practice respiration through the opening when the mouth is closed. The opening into the lung is about one inch in diameter, and is surrounded by extensive marks of ulceration. The last cervical, 1st, 2d, 11th and 12th dorsal vertebræ are carious, and discharge pus. The spine has both a lateral and anterior curvature. The head is forced down upon the chest. It is necessary for the patient to carry a pad upon the chin in order to facilitate respiration. Lateral and anterior and posterior motions of the head almost entirely lost. Ulcers exist over the neck and breast and sternum, which discharge pus and fragments of bone. Pus, with fragments of bone, issue from the ear. A large ulcer is also

SUBJECTS.	AGE..........	WEIGHT..........	From ground to perpendicular in front to vertex of the head.	From vertex, along circumference of spine to end of heel.	From bottom of heel to external condyle of the femur.	From external condyle to trochanter major.	From trochanter major to crest of illium.	From crest of illium to spine of scapula.	From one acromion process to the other across the shoulders.	Length of thorax from middle of clavicle to inferior border of ribs.	Circumference of chest around the nipples.	REMARKS.
			ins.									
Berry Subbs..........	20	92	51	61	19½	14	4¼	10½	14¾	9¼	30¼	Berry Tubbs, w'ght at 13 years, 120 pounds.
1st. Healthy subject	21	131	69¼	70½	20	16½	6½	16	16	13½	34¼	
2d. " "	20	136	70	71	19¼	15½	6½	16	17	14	36	
3d. " "	20	180	70¾	71½	21	17	7	15	16½	13	36	
4th. " "	19	136	69	69¾	19	16¼	6	16¼	15½	14	32½	
5th. " "	19	140	70	71¼	21¼	17	6½	14¼	15½	15	33	

found in the left axilla, which penetrates through the ribs into the lungs, and respiration is performed through this as well as through the one previously described. Several of the bones of the feet and hands are in like manner carious. Pulse, in sitting posture, 102, standing, 120; respiration, sitting, 32, standing, 48; temperature of hand, 98.°5, under tongue, 99.°5. Very feeble, walks with great difficulty. The heart has been displaced and rests beneath the upper portion of sternum. Left lung contracted, right lung much consolidated. Died apparently from suffocation, December 20th. The preceding measurements will illustrate the effects of the caries of the vertebræ and ribs in altering the proportions of the form in this case.

CHAPTER XXII.

RELATIONS OF MOLLITIES OSSIUM TO RICKETS (RACHITIS).

Deficiency of phosphate of lime characteristic of both Rickets and Mollities Ossium; the former confined to no sex; a disease of childhood, and capable of cure; the latter most commonly attacks adult females, and is almost universally fatal—Distinctions between the changes of the bones in these two diseases—Results of microscopical investigations.

Upon a superficial view, rickets and mollities ossium appear to be closely connected on account of the flexibility of the bones and the fractures upon slight causes which characterize both diseases. Some authors, led by these general resemblances, have regarded the latter disease as rickets attacking the adult. A careful analysis and comparison of the phenomena of the two diseases, however, will show that the resemblances of the two affections are far exceeded by their differences.

A deficiency, actual and relative, of phosphate of lime in the osseous system, characterizes both mollities ossium and rickets; in the former, however, the skeleton, originally normal in structure, loses its earthy matter, becoming fragile, soft and pliable; in the latter, the osseous structure is abnormal from the first, or from an early age. Guerin found that of 346 cases of rickets, 209 were affected between the first and third year, these were congenital; 34 occurred between the ages of four and twelve; 148 were males and 198 females. Cases of congenital rachitis have been mentioned by Hippocrates and other writers.

Mr. Tamplin* has described a skeleton affected with rickets in a seven months' fœtus. Rickets has been observed in the young of wild animals (lions and tigers) born during the captivity of their parents. The disease appears to be intimately connected with a marked cachexy of the system, which seems to be identical with the scrofulous, and to be induced by insufficient nourishment combined with bad hygiene, and damp, foul air. The process of dentition also, by the disturbances which it causes in the alimentary canal, and by the drain which it establishes upon the mineral constituents of the blood, tends to develop and aggravate the disease.

On the other hand, mollities ossium attacks adults, and especially women after they have commenced child-bearing.

Mr. Curling states: that "there is a skeleton in the collection of the College of Surgeons in Edinburgh, where the spine, thorax and pelvis, are greatly distorted by the disease, taken from a female, who had had seven children, each labor having been accompanied with increased difficulties, and the death of all the children, except the last child, whose life was saved by the performance of the Cæsarian Section, which operation, however, proved fatal to the mother. Medico-Chir. Trans., vol. x, p. 361.

In the sixteen cases collected by Mr. Curling,† thirteen occurred in females, and only three in males; eleven were fatal between thirty and forty; in none did the disease show itself before puberty; but two patients were above fifty years of age, and several of them were delivered of children during the progress of the complaint.

The softening of the bones is slow and gradual in rickets, and unaccompanied by pain.

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* Lectures on the Nature and Treatment of Deformities. Am. ed., pp. 156–157.

† Medico-Chirurg. Trans., vol. xx, p. 336.

while in mollities ossium it is sudden and rapid in its progress, and accompanied often with great pain.

The progress of this affection of the osseous system varies greatly, the bones becoming atrophied in some instances in a few months; more commonly, however, the disease is extremely chronic, going on for many years before the death of the patient. In most cases, it is noticed that the various functions were duly performed, unless interfered with by the destruction consequent upon the yielding of the bones, and it is distinctly stated that the internal organs were found in a healthy condition after death, showing that the disease is not associated with any particular lesion of important viscera.

Sir Charles Bell,* in his *Lectures, Illustrated by the Hunterian Preparations*, quotes from the "Medical Observations and Inquiries," a remarkable case of Mollities Ossium, where a man going up stairs struck his toes against a step, and broke his thigh bone. The surgeon attended, with all proper appliances, to the thigh bone, but the usual period expired without union being discovered at the fractured part. A consultation being called, on raising the leg the thigh-bone broke again in the hands of the surgeons. The disease proceeded to such an extent that the flexor muscles twisted the bones, so that the heels were drawn back of the head, and the trunk itself before death, became greatly flexed.

Mollities Ossium progresses, in almost all cases, to a fatal issue; in rickets, after a time, the abnormal condition is cured by treatment, or the progress of age; earthy matter is deposited in even more than its due proportion, the skeleton becomes solid and strong, and the general health may be entirely restored.

If the patient outlive rickets and die afterwards, it will be found, upon dissection, that the bones have assumed great weight and density, and, in some instances, the cavities of the cylindrical bones are said to have been filled up with earthy matters. And it has been noticed, in some instances, that such persons, on recovery from the disease, acquire a surprising degree of strength. Sir Charles Bell* mentions an individual by the name of Farrel, known on the streets of London as "Leather-coat Jack," who would throw himself under a hackney-coach, and allow the wheel to go over him, for a pot of porter. This short, deformed man, who had been afflicted with rickets in his youth, exhibited great feats of strength, bearing an anvil on his breast, and carrying the tallest men by placing his arms under their thighs. Sir Charles Bell also cites the extraordinary manifestations of strength by another dwarf, and rickety subject, called the "Little Hercules."

The general health in Mollities Ossium is hopelessly impaired, the flesh and strength diminish daily, and in some cases the muscles undergo fatty degeneration. The observations thus far recorded, have not been sufficiently numerous or accurate to decide the question whether the degeneration of the muscles is always present in this disease. The fatty degeneration of the muslces in those cases in which it has been observed can with great reason be referred to the action of the same causes which induced the softening and degeneration of the bones.

The pale color of the muscles in some cases of rickets appears to be due to the anæmic condition of the system, rather than to fatty degeneration of the muscles; and we have just seen that after recovery from this disease, the muscular strength, so far from being impaired, is often wonderfully increased.

In Mollities Ossium, the loss of earthy matter in the osseous system is rapid, and is frequently attended with a copious phosphatic deposit in the urine, and the bones do not simply lose their earthy constituents and become reduced to their cartilaginous flexible tissue, but there is an actual change in the living cellular elements of the bones, and a progressive degeneration, so that in many cases, the bones consist finally of an external shell filled with oily or lardaceous matter held in membranous tissue.

According to Mr. Curling, the atrophy is eccentric, commencing invariably from the interior of the bones; in the long bones, affecting first the internal part of the shaft, or more dense and compact part of the osseous tissue, and subsequently extending to the vascular cancellous extremities, until, if the patient survives, no part of the proper osseous structure remains, its place being supplied by increased secretion of medulla.

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* London Lancet, March 15, 1834, p. 918.

In the flat bones, the diploe first becomes affected, and the atrophy goes on in like manner from within outwards, until the two external tables are entirely destroyed, and nothing but the medullary tissue remains. In the majority of instances, the atrophy commences first in the bones of the lower extremities, and extends afterwards to those of the upper and of the trunk, so that eventually no parts of the bony system escapes. The teeth have never been known to become affected in this disease, affording another argument in favor of the view which regards them as independent of the laws that regulate the osseous system. It is remarkable that even in the most extreme cases of this disease, no change is produced in the articulating cartilages, nor in the periosteum, with the exception of a little thickening occasionally observed in the latter. In the case reported by M. Saillant, the long confinement appeared to have led to atrophy of cartilage and anchylosis of the patella, also of several of the vertebræ and bones of the carpus. Mr. Curling refers the presence of fractures, and the absence, in other cases as well marked, to modifications in the wasting process—upon the more or less rapid decay of the earthy parts, as compared with the animal constituents. Thus, when the earthy parts waste faster than the softer structures, there is distortion without fracture; but, on the other hand, when the animal parts waste more rapidly than the earthy materials, then there is fragility without distortion. In some cases, however, there is fragility in the first instance, and afterwards, when the disease is farther advanced, distortion. These physical properties being dependent solely upon the difference that exists in the relative proportions of the earthy and animal matters.

Though pathologists are still in doubt as to the exact nature of the change of the osseous system in this disease, the observations of Mr Solly and of Mr Dalrymple have shown the existence of a process of active change, as manifested in the afflux of blood to the parts affected, and the abundant cell growth. Mr Dalrymple has found by microscopical observation, that the bone corpuscles are considerably enlarged. Enlargements of the Haversian canals and of the lacunæ is observed. [illegible] are loaded with large oil drops, often tinted red, and combined with [illegible] varying in size from the [illegible] of an inch [illegible] also varying much in size, and constantly showing various stages [illegible] endogenous development. And while there is a [illegible] there is at the same time some important change [illegible] the animal basis [illegible] no longer yields healthy gelatin, and is saturated with [illegible] contained in cells, but lies as a free fluid [illegible] readily drains out when the bone is placed [illegible] peculiar, presenting bright yellow [illegible]. These changes are probably owing, as Bennett has said [illegible] more or less extravasation [illegible] combined with fatty transformation [illegible] materials.

Virchow has traced [illegible] inflamed bone as a part of the process of softening which precedes its [illegible]. Very often small fatty molecules appear in the bone-corpuscles, and Virchow has traced [illegible] and the gradual softening [illegible] of the proper bone substance immediately surrounding [illegible]. Analogous changes have been traced by [illegible] and Rokitansky in cartilage, and Virchow has pointed out their relation to fatty [illegible] as a part of the inflammatory process; and that changes in inflamed [illegible] the results of the same process as that by which [illegible] medullary spaces are [illegible] bone are formed, and by which [illegible] is supposed to be produced.

On the other hand, the softening of the bone in rachitis should be regarded as arrested development of bone with an increased growth of cartilage-cells. In this disease the whole bone is soft, easily cut with a knife, and preternaturally flexible [illegible] ture of a brown or reddish hue predominates, and is at first filled with a serous liquid, which may be squeezed out, as if from wet leather; after some time the serous or albuminoid liquid occupying the tube and cancelli is transformed into a gelatinous substance, which is gradually organized into a cartilaginous state. The power to separate and deposit bony or earthy matter appears to be entirely wanting in the organic cells of the osseous system in mollities ossium, whilst in rachitis this power is only temporarily suspended or arrested, and is resumed with increased energy after the removal of the diseased state.

Mr. Edward Stanley, as early as 1816, in a valuable article, published in the Seventh Volume of the Medico-Chirurgical Transactions, described the process of restoration of the Bones in Rickets. Mr. Stanley endeavored to show in this paper, how the soft rickety bone, which presents an almost uniform structure throughout, being without any distinction into solid walls and medullary cavity, becomes changed into the condition in which it will be found, when upon the restoration of healthy actions it has acquired strength and power of resistance. Previous to the investigation by Mr. Stanley, very few observations had been made respecting rickety bones, during the continuance of their soft state or state of disease, and none at all respecting the process by which they resume their solid and healthy condition. Léveillé had given an account of the structure of a soft, rickety bone, with a representation of its curved figure. It is described as having been exceedingly light, yielding with facility to the scalpel, and presenting throughout a cellular and spongy texture. Mémoires de Physiologie et de Chirurgie pratiqué par Sacrpa et Léveillé.

Bichat remarked, concerning the condition of the bones in rickets: "In this disease the solid structure forming the walls of a long bone entirely disappears, the whole interior of the bone presents a homogeneous appearance, and cellular texture throughout; the periosteum is also thickened." (Anatomie Générale, Tom. iii.)

The several bones examined by Mr. Stanley, exhibited nearly the same structure as that here described by Léveillé and Bichat, excepting that the periosteum was not thickened as is mentioned by the latter; the consistence of the bones was nearly that of common cartilage, they presented throughout an areolated texture, and the cells were in some parts large, and contained a brownish, gelatinous substance.

Such is the state of the soft ricketty bone, during the continuance of the diseased action which constitutes rickets; but to this there must necessarily succeed some process of restoration, some new modelling of its internal structure, in order to produce that distinction between the external walls and internal cavity which it is afterwards found to acquire. From an examination of a series of rickety bones, which had undergone different degrees of curvature, and where the process of restoration had been completed, Mr. Stanley discovered that there invariably obtains an exact relation to the circumstances of each case, with respect to the situation, extent and direction in which the earthy matter is deposited; thus it is obvious that in the curved bone, the part where there is the greatest need of strength, to prevent its further yielding, is in the middle of its concavity, or in other words, in the line of its interior curve; and it is just in this situation that strength and compactness will be first imparted to the bone by the deposition of phosphate of iime. Mr. Stanley farther found that the greatest resistance being wanted at this part, the walls were accordingly rendered thicker here than elsewhere, and the degree to which this excess in thickness was carried, bears an exact ratio to the degree of curvature which the bone has undergone. Mr. Stanley introduced an example drawn from a principle in mechanics; thus if a weight be placed upon the top of a hollow elastic cylinder curved to the degree of one, and the same weight is placed upon the top of another cylinder curved to the degree of three, in the latter case, the superincumbent weight will tend to increase the bending of the pillar with a greater force than in the former; if therefore it becomes necessary to apply in both cases a power of resistance, this ought to be so much greater in that instance where the disposition to bend is greater. It is obvious what will be the application of this principle to the strengthening of a curved, rickety bone, as may be readily exemplified by examining bones that have suffered different degrees of curvature; thus according to the extent in which a bone has yielded, and the weight it has to support, the thickness and solidity of the walls in the line of the interior curve, will be found greater than in any other situation; it will also be noticed that the bony fibres are arranged obliquely across the axis of the bone, in a direction evidently calculated to augment its strength and power of resistance. Lastly, if such a bone as the tibia has become bent perhaps into an angle, or so as to form the greater part of a circle, and at the same time it has to support a great superincumbent weight, the deposition of the bony matter may not be confined to the thickness of the walls in the concave side, but may extend across the medullary cavity, rendering the bone here perfectly solid, and thereby greatly augmenting its strength and power of resistance.

Mr. Stanley presented to the Society three drawings, the first representing the internal structure of a rickety bone in its softened and diseased state; the two others representing sections of bones differently curved, but which had by the restoration of healthy action, acquired compactness of structure. In one, the deposition of bony matter is confined to the thickening of the walls of the concave side; in the other bone a tibia which has become bent into an angle, the medullary cavity is filled by osseous matter at the part which has yielded, and the bone consequently made solid in this situation. (Medico-Chirurgical Transactions, London, 1816, vol. vii, pp. 404 to 410.)

I have confirmed the accuracy of Mr. Stanley's observations by making careful sections of rickety bones.

CHAPTER XXIII.

RELATIONS OF MOLLITIES OSSIUM TO CANCER.

The brittleness of the bones in cancer has long been observed—Cases recorded of softening and alterations of the bones, by Lovisius, Percival Pott, and Prof. R. W. Smith.

Mollities Ossium, in that, as far as is known, it is not amenable to remedies, but pursues its career steadily, unaffected for good by medical treatment; and in that there is in this disease an increased cell-generation in the affected structures; and, still further, in that, in recorded cases of cancer, some of the bones have been found in a state closely resembling, if not identical with mollities—bears a stronger resemblance to cancer than to any other disease.

The brittleness of the bones in cancer has long been observed. Thus, the celebrated Lovisius, more than a century ago, in dissecting the body of a woman sixty years of age, who had labored for some time under a cancer of the breast, and who had broken the os humeri, and, soon after, the os femoris also, by a slight effort found the bones not carious, but dry and fragile, with the medulla, in like manner, dry, friable, and quite loose from the parieties of the bony cavities.

In a case which recently came under my observation in the Charity Hospital, of cancer of the breast in an aged negro woman, several of the ribs on both sides were soft, cartilaginous, and readily cut with a knife. Cancerous deposits were found also in the liver and spleen.

In the following case, recorded by the celebrated Percival Pott, it will be observed that softening of the bones was attended with fever, great muscular debility and pain, and the formation of steatomatous and scirrhous tumors.

Case 780*: In November, 1737, a gentleman, aged 27, complained of a swelling in the inside of his right thigh. On examination, it appeared to be an encysted tumor of the steatomatous kind, lying loose between the sartorius and vastus internus muscles. Mr. Pott took it out, and the patient got well in six weeks. After this he continued well for near a year, except that he complained at times of a slight pain in the joint of that hip, which went off and returned at different times. He then fell into such a disposition to sleep, that no company nor diversion, nor his own endeavors to the contrary, could keep him awake after eight or nine o'clock in the evening, if he sat down. This continued on him for three or four weeks, and then the pain in his hip became worse. The cold bath, flesh-brush, horseback exercise, a course of æthiops mineral, cinnabar, of antimony, gum guaiac, calomel, purgatives and mineral waters, as well as travelling and change of climate, afforded no relief. Periodical heat and thirst returned every night, with a quick, hard pulse.

In September, 1739, the sight of his left eye became dim, and the dimness gradually increased until the sight was lost, and the ball of the eye was enlarged and thrust forward out of the orbit.

Tumors appeared in different parts, five or six on his head, two or three in his back and one in the neck, all lying just under the skin.

December 2d, 1739, his chief complaints at this time was excessive languor, inability to move his right hip, and when moved by another person, a very acute pain in it, an incapacity of sleeping when in bed, an intense thirst in the night, with a quick, hard pulse.

After subjecting himself to several courses of treatment, with cinnabar, of antimony, mercury, and other remedies, without any benefit, and being reduced extremely low, he abandoned physic. The inguinal glands of the hip became much enlarged, the patient lost all power of stirring or helping himself, and died May 2d, 1740.

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* An Account of Tumors which rendered the Bones Soft. Communicated to the Royal Society by Mr. Percival Pott, Surgeon, 1740. Vol. xli. No. 459, p. 616. Abridgment, vol. viii, pp. 462–467.

For a considerable time before he died he was nourished by fluids only; yet as soon as ever they were received into the stomach, in however small a quantity, they gave him acute pain at the bottom of his belly, just above the pubes. Upon dissection, Mr. Pott found the tumor which he had taken out of his thigh two years before ossified in the inside.

On dissection, the first thing that offered was a large tumor on the sternum, which had been perceived about three months before he died. It was as large as a turkey's egg, and so hard and immovable that Mr. Pott was in doubt whether it was upon or under the bone. On removing the skin, it appeared covered by the expansion of the tendons of the intercostal muscles and the periosteum; this coat being taken off, it was of a suety kind of substance for about half an inch deep, and below this was a kind of cartilage intermixed with a great many bony particles. Mr. Pott then shaved off all this diseased body even with the surface of the rest of the sternum, but found no bone, it being quite dissolved and confounded with the mass of matter that composed the tumor, which was equally protuberant within the thorax, and composed of the same materials.

Parts of the fifth and seventh ribs were dissolved in the same manner, into a kind of substance between bone and cartilage, with a thin coat of steatomatous matter.

Within the cavity of the thorax were thirty-seven of these diseased bodies, most of them attached either to the vertebræ or the ribs; and wherever they were attached the cortex of the bone was destroyed, and its internal cellular parts filled with diseased matter.

Immediately above the diaphragm, was a large scirrhous body, lying across the spine and the aorta, the latter of which lay in a sinus formed in its lower part: it had no attachments to any other part, and weighed 13½ ozs.; and from its situation must have taken its rise from *some* of the lymphatic glands lying about the thoracic duct.

From the origin of the aorta from the heart quite up to the basis of the cranium, all the blood-vessels were surrounded with these scirrhous bodies, and the thyroid gland was diseased in like manner, and bony within. On the left side was another of these bodies, made out of the glandulæ renalis, weighing 9¼ ozs.

On the right the glandulæ renalis was in a natural state, but the cellular membrane which surrounds the kidneys was filled with a large cluster of these bodies of different sizes, some of them entirely suety, intermixed with bony particles; three or four of them were attached to the body of the kidneys, and there was a sort of cartilage beginning to ossify.

The pancreas was quite scirrhous and very large. One very large tumor sprang from the spongy body of the third vertebra of the loins, the bony texture of which was so dissolved and mixed with the matter of the tumor, that the knife passed through it with great ease. The inner side of the os ilium, all the ischium and pubis, were covered with these appearances, and on removing them the bone was found in the same state as the sternum and ribs. The middle of the right os femoris was surrounded with a mass of the same matter, and the bone underneath in the same state.

In the bottom of the orbit, surrounded by the recti muscles, was a pretty large steatoma which occupied the protrusion of the eye, and by pressure on the optic nerve caused the blindness.

In diffused cancer the whole bone may be softened by the distension of its cells with the material of soft cancer, the cancelli may be partially or completely absorbed, and general disintegration of the bone induced. And it would appear that some cases described as mollities ossium were really instances of diffused cancer of the bones. And in the close resemblance of the two affections must be found the grounds upon which some authors have classed mollities with cancer. This confusion is not to be wondered at when the obscurity and difficulty which surround the history and investigation of cancer of the bones are considered.

Professor R. W. Smith, of the University of Dublin, has recorded a remarkable case of cancer in the bones, a brief outline of which we give.

CASE 781[1]: The patient was a female, æt. 63, of sallow complexion and very unhealthy appearance.

Four years before her death, and eight after the catamenia had ceased, she began to suffer from lancinating pains in the left breast, and a small, hard tumor formed near the nipple, and very soon became adherent to the skin, was uneven upon the surface, and after some time the axillary glands became enlarged and indurated. The tumor underwent no further change

[1] Dublin Hospital Gazette, March [illegible], 1855; Ranking's Abstract, No. XXII, July to December, 1855, p. 113.

for two years and a half, when a scab formed upon its surface, upon the separation of which, a very superficial ulcer not as large as a shilling remained; this sore never increased either in extent or depth, and yielded but little discharge. In fact, during the remainder of her life, the diseased breast attracted no share of her attention, and the lancinating pains which were first experienced latterly ceased altogether. Severely, however, and almost unceasingly, did she suffer from pains, which she conceived to be of a rheumatic character, in all her bones; she had cough and pain in the right side; her appetite failed, her sleep deserted her, and her flesh wasted away; she was for a long time before her death completely bedridden; she could not endure that any one should touch her; and her efforts to move herself in the bed were, upon several occasions, followed by fracture.

She died exhausted by pain and suffering and in a state of complete emaciation.

The post-mortem examination, which Dr. Smith conducted with the greatest care, proved most interesting, and revealed an immense extent of cancerous deposit limited to a single system; for, with the exception of a tubercle about the size of a small nut in the liver, the organs, in all the cavaties, were perfectly healthy; while, upon the other hand, nearly the entire skeleton from the head to the feet was pervaded with cancer.

The cranial bones in several places had been softened and absorbed; the left clavicle was fractured external to its centre, and the anterior of the bone was occupied by scirrhous matter, from its sternum to its acromial extremity; the left humerus was broken in its centre, and the cancerous deposit filled the medullary canal from the head of the bone down to its lower extremity; both the right and left thigh bones were fractured and in portions absorbed and universally infiltrated with the cancerous structure—the medulla of the bones of the legs presented a most unhealthy appearance; the ribs contained numerous deposits of scirrhus in their interior, and several of them were fractured; the disease occupied the spinal column from the lower part of the cervical region to the sacrum, the cancellated tissue of the bones had disappeared, and its place was occupied by a firm, elastic, scirrhous structure of uniform consistence and of a roseate hue; and the bones of the pelvis were entirely converted into a scirrhous structure.

The characters of this heterogeneous deposit were precisely the same in all the affected bones; it was white, firm, tough, and dense in its texture, highly elastic, and cut like cartilage; it in no respect differed from true scirrhus as it is seen in the human breast. The osseous tissue in contact with it had suffered no alteration but such as resulted from absorption.

It is evident that such a case as the preceding was involved in obscurity during the life of the patient, and simulated closely mollities ossium in many of its symptoms.

In a case of secondary cancer in the spine and other parts after removal of scirrhus of the breast, reported by Mr. Cæsar Hawkins, the centre of the neck appeared a little sunk forwards, as if the upper vertebræ had been depressed in that position. Upon dissection, the body of the fifth cervical vertebra was very irregular on its surface, and was softened throughout, with much enlargement of the cells of the cancelli, which was filled with a sanguineous pulpy fluid; the two adjoining vertebræ showed a lesser degree of the same morbid structure. Mr. F. Holmes has recorded a case of cancer of the bones after scirrhus of the breast, in which some of the ribs were perfectly flexible; and in a case of well-marked cancer of the pelvis, he found a condition of the innominate bone bearing an almost equally close resemblance to mollities.

In some cases of cancer, where the disease involves the soft parts as well as the osseous texture, it is sometimes difficult to determine in which tissue the disease had its origin; it appears to be true, however, that whether the bone be primarily or secondarily affected, its density is altered and it is rendered more fragile and spongy in its texture.

It would appear that in this disease, in like manner, with mollities ossium and syphilitic inflammation and ulceration, the earthy constituents are acted upon and dissolved by acid fluids. In the case of the cancerous growth, it may be that the dissolved phosphate of lime may take some part in the growth of cancer cells; it certainly is deposited in a peculiar manner in and amongst these cells, which partake in the case of bone, of the character to a certain extent of rapidly growing cartilage cells. The following cases occurring in our practice in the Charity Hospital, will be of interest in this connection.

We have preserved in our pathological laboratory, two femurs from two cases of cancer [illegible] thigh. [illegible] the following [illegible] cases, with the prepared specimens:

[illegible] affected with cancer of the [illegible]

[illegible] inches [illegible] rough [illegible] of bone. [illegible]

[illegible] inches. Weight [illegible] native of Norway [illegible] years, had syphilis [illegible] years ago [illegible] swelling [illegible] began to [illegible] swelling commenced the patient [illegible] was placed [illegible] and the general [illegible] disappeared, but [illegible] The pain [illegible]

[illegible]

under axilla, 100°. Appetite poor, bowels torpid, skin moderately cool, except over the affected thigh. The thigh felt nodulated and hardened, and the disease was pronounced to be a malignant growth surrounding and involving the bone. Exploration with trochar gave no evidence of pus. The right thigh continued to enlarge, and the knee and leg became œdematous. On the 18th of August, the right thigh measured at knee, sixteen and a half inches in circumference; at middle, twenty-five inches; at junction with trunk, twenty-two inches. The sound left thigh measured at knee, eleven inches; at middle, twelve inches, and at the junction with trunk twelve inches. The following are the observations on the pulse, respiration and temperature upon the four days preceding death:

August 25, 9 A. M.	Pulse 96;	respiration 16;	temperature of axilla 101°.2
" 6 P. M.	" 96;	" 16;	" " 100°.5
August 26, 9 A. M.	" 88;	" 16;	" " 99°.5
" 6 P. M.	" 86;	" 16;	" " 101°.2
August 27, 9 A. M.	" 88;	" 16;	" " 100°.5
" 6 P. M.	" 85;	" 16;	" " 100°.5
August 28, 9 A. M.	" 88;	" 15;	" " 99°.5
" 6 P. M.	" 86;	" 15;	" " 100°.0

Died August 12th. The forces gradually gave way without any marked symptoms. Before death, the emaciation had been extreme.

The following are the results of the post-mortem examination:

Exterior:—Great emaciation. No mammary development upon chest. Right thigh greatly enlarged; left, a mere shadow; the bone with the skin and thin layer of muscles.

Chest:—No adhesions. Lungs emphysematous. Pericardium contained considerable fluid.

Abdomen:—Peritoneum very thin; sigmoid flexure greatly distended with gas; small intestines greatly contracted and anæmic.

Liver friable, and on its convex surface a small circumscribed abscess. Kidneys lobulated, and contained cysts and small abscesses. Generative apparatus poorly developed. The abdominal aorta, and its branches, presented appearances of calcareous degeneration. The blood was remarkably thin.

The right thigh was carefully dissected. A large encephaloid cancer involved the muscular structures of the thigh and surrounded the bone, and numerous osseous spiculæ extended from the femur into the cancerous mass. Under the microscope the tumor was found to consist of cancer cells, fibrous tissue, oil globules and granular masses. At one portion near the head of the femur, the tumor was undergoing softening, and this portion was loaded with granular matter.

CHAPTER XXIV.

CONSTITUTION OF THE BLOOD, CONDITION OF THE TEMPERATURE, PULSE, AND RESPIRATION, AND THE CHARACTERS OF THE URINE, IN MOLLITIES OSSIUM.

Observations of Dr. Bence Jones and Marchand.

Constitution of the Blood in Mollities Ossium.—As far as our information extends, no analysis has been made of the blood in this disease. The future investigator should direct his attention not merely to the determination of the albumen, fibrin, and red corpuscles, but should endeavor to determine whether any special acid or salt exists in the blood in excessive quantity. A careful search should be instituted for lactic and phosphoric acid, and for lactates and phosphates.

Temperature, Pulse, and Respiration in Mollities Ossium.—In like manner we have no critical observations upon the state of the temperature, circulation, and respiration in this disease, and we know but little beyond the general observation that the pathological phenomena are attended by fever.

Progress and Termination of Mollities Ossium.—The various functions appear to have been duly performed in most cases, unless interfered with by the distortion consequent upon the yielding of the bones; and pathologists have distinctly stated that the internal organs were found in a healthy condition after death, thus showing that the disease is not associated with any particular lesion of important viscera.

The progress of mollities ossium appears to vary greatly, the bones becoming soft in some cases in a few months; more commonly, however, the disease goes on for many years before the death of the patient.

Condition of the Urine in Mollities Ossium.—The observations which we have already recorded establish the fact that the phosphates are frequently in excess in the urine of this disease. We need an extended series of analyses of the urine, collected during definite periods of time (twenty-four hours) and at stated periods in the progress of the disease.

The most complete and interesting examination of the urine in this disease was made by Dr. Henry Bence Jones.[*] It is to be greatly regretted that, in his analysis, Dr. Jones selected an arbitrary quantity (1000 grains,) instead of the whole amount excreted during twenty-four hours.

This case was reported both by Dr. William Macintyre[†] and by Mr. Dalrymple.[‡]

The following is an outline of the report of this case by Dr. Macintyre:

CASE 784: A tradesman, aged 45, came under Dr. Macintyre's care on the 30th of October, 1845. He had suffered for upwards of twelve months from excruciating pains in the chest, loins, and back. When first seen, he was much emaciated; the pain had become fixed in the left lumbar and iliac regions, and the patient, in consequence of the great agony produced by moving the body on the thighs, was constantly in a semi-flexed position. There was exquisite tenderness on pressure at the brim of the pelvis in front. Nothing very satisfactory could be made out regarding the abdominal and thoracic organs, except that the cardiac impulse was too strong, and the præcordial dullness too great, without cardiac murmur.

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[*] On a New Substance occurring in the Urine of a Patient with Mollities Ossium. By Henry Bence Jones, M. A., F. R. S., &c. Philos. Trans., 1848 p. 55.

[†] Case of Mollities Ossium and Fragilitas Ossium accompanied with Urine strongly charged with Animal Matter. Med.-Chir. Trans., vol. xxxiii., 1850.

[‡] Dublin Quarterly Journal, 1846, p. 85. Path. Soc. Trans., 1840-7; p. 148.

The patient attributed his illness to a strain, but it appears that for some time previously he had been subject to wandering pains about the breast and shoulders. The urine of this patient was submitted to the examination of Dr. Bence Jones, with the following result. The free acid was increased, the phosphates were in much larger amount than in health, and the urine was loaded with a peculiar form of animal matter resembling albumen in its chemical composition coagulable by heat, but not by nitric acid.

The following table presents the general characters of the urine, as determined by Dr. Bence Jones:

Date.	Specific gravity	Earthy phosphates in 1000 parts.	Reaction.	Precipitates, &c.
Nov. 1, 1845.	1034.2		Slightly acid.	Sediment of phosphate of lime oxalate of lime, and urinary casts.
" 3, "	1043.2	5.68	Acid.	Urate of ammonia, phosphate of lime, and urinary casts.
" 7, "	1039.6	5.65	Slightly alkaline.	Phosphates of lime and casts.
" 8, "	......	.....	"	Heavy deposit of phosphates.
" 9, "	1037.2	.....	"	Loaded with urates.
" 18, "	1039.6	.....	Acid.	Urate of ammonia, phosphate of lime, and oxalate of lime.
" 27, "	1031.3	8.05		
" 29, "	1037.9	8.24		
" 30, "	1042.7	11.85	Slightly acid.	No fibrinous cylinders.

The complete analysis of 1000 parts of urine, on the 18th of November, gave—

Water	890.72
New substance (resembling albumen)	66.97
Urea	29.90
Uric acid	0.96
Earthy phosphates	1.20
Chloride of sodium	3.83
Sulphate of potash	2.10
Alkaline phosphates	4.45

The following are the conclusions arrived at by Dr. Bence Jones, after a careful examination of the peculiar albuminoid substance in the urine:

1st. This substance is an oxide of albumen, and from the ultimate analysis, it is the hydrated deutoxide of albumen.

2d. In this case of mollities ossium, 66.97 parts of this hydrated deutoxide of albumen were passing out of the body in every 1000 parts of the urine. Hence, therefore, there was as much of this peculiar albuminous substance in the urine as there is ordinarily albumen in healthy blood. As far, then, as the albumen alone is concerned, each ounce of urine passed was equivalent to an ounce of blood lost.

3d. The peculiar characteristic of this hydrated deutoxide of albumen was its solubility in boiling water, and the precipitate with nitric acid being dissolved by heat, and re-formed when cold. By this reaction a similar substance in small quantity may be detected in pus and in the secretion from the vesiculæ seminales.

4th. This substance must again be looked for in acute cases of mollities ossium. The reddening of the urine on the addition of nitric acid, might perhaps lead to the re-discovery of it; when found, the presence of chlorine in the urine, of which there was a suspicion in the above case, should be a special subject of investigation, as it may lead not only to the explanation of the formation of this substance, but to the comprehension of the nature of the disease which affects the bones.

This patient died on the 2d of January. On the following day, Dr. Jones saw that the bony structure of the ribs was cut with the greatest ease, and that the bodies of the vertebræ were capable of being sliced off with the knife.

According to Mr. Macintyre, the sternum, ribs, and cervical, dorsal and lumbar vertebræ were found soft and brittle; the cancellated structure loaded with a blood-red, soft, gelatiniform substance, which, under the microscope, was found composed of granular matter, oil globules, nucleated cells, with a few caudate cells, and blood disks. The thoracic and abdominal organs presented nothing unhealthy. The patient's death took place without any satisfactory opinion having been arrived at as to the nature of the case.

We do not gather from the record of this post-mortem, whether the kidneys were diseased; the appearance of the modified albumen may have been due to the existence of Bright's disease of the kidneys. Future inquiries should determine whether this substance is characteristic of mollities, and whether the lactic acid, and lactates and sulphates, as well as the phosphates, are increased in the urine.

CASE 785: Marchand* analyzed the urine of a child with osteomalacia three days before its death.

The fluid was invariably acid, and contained in 1000 parts:

Water	938.2
Solid constituents	61.8
Urea	27.3
Uric acid	0.9
Lactic acid and lactates	14.2
Phosphates of lime and magnesia	5.7
Other substances and loss	13.7

Not only were the earthy phosphates, in this instance, five or six times as abundant as in health, as was the case in one of the instances of this disease recorded by Mr. Solly, but what is especially interesting, in its bearings upon the nature of mollities, the LACTIC ACID and LACTATES *were greatly increased.*

*Simon's Animal Chemistry, Am. ed., p. 511.

CHAPTER XXV.

COMPARISON OF THE CHEMICAL COMPOSITION OF THE BONES IN MOLLITIES OSSIUM WITH THAT OF HEALTH AND VARIOUS DISEASED STATES—GENERAL CONCLUSIONS.

Analysis of healthy bones by various chemists, and of the bones in Mollities Ossium and various diseased states, by Bostock, Prösch, Bogne, Ragsby, Lehmann, Von Bibra, Marchand, Reese, Tuson, Barruel, Buisson, Valentin, and others—General conclusions as to the nature of Mollities Ossium.

Notwithstanding the comparative simplicity of the analysis of bone, much remains to be accomplished before the true nature of its alterations in various diseases are determined with accuracy. Unfortunately, many analyses of morbid bones are unaccompanied by any minute or accurate history of the case. In such a disease as mollities ossium, it would be of the greatest importance to determine whether, in the resorption of the bone earth, the strongly basic phosphate of lime is replaced by a less basic salt.

The neglect to ascertain the quantity of the carbonate of lime in the fresh bone, or in the earthy constituents, by the direct determination of the carbonic acid, as well as the employment, in most analyses of bones, of the older method of Berzelius for the determination of the phosphate of lime, has left it doubtful whether it exists in bone as $8CaO, 3PO_5$ or $3CaO, PO_5$.

The following tables will present the most important results obtained by chemists, and at the same time furnish data for the determination of the characteristic changes in mollities ossium.

Becquerel and Rodier give the mean composition of human bone, as deduced from fifty-four analyses, made by different experimenters, as follows:

Phosphate of lime	54.07
Phosphate of magnesia	1.20
Carbonate of lime	7.40
Fat	1.35
Soda and salts of soda	0.93
Cartilage	35.05

Lehmann represents the constitution of compact osseous tissue, as deduced from the best analysis, as:

Phosphate of lime	57
Carbonate of lime	8
Fluoride of calcium	1
Phosphate of magnesia	1
Mineral constituents	67
Cartilage	33
	100

The comparison of the composition of the bones in mollities ossium with that of health, reveals the following marked changes:

1. Increase of fat.

2. Decrease of phosphate and carbonate of lime.
3. Relative increase of organic or cartilaginous matter.

Whilst the fat in healthy bones may vary between one and two parts in the hundred, in mollities ossium, on the other hand, according to Prösch, the fat varies from 5.26 to 11.63; according to Lehmann from 29.18 to 34.15 parts; according to Von Bibra, from 4.15 to 13.28; according to Marchand, from 6.12 to 9.34; according to Garrod, 20.35.

In health the phosphate of lime may vary in different bones; in the adult, between 54 and 60 parts in the hundred; in mollities ossium, according to Bostock, it reached only 13.6 per cent.; according to Prösch, it varied between 13.25 and 33.66; according to Bogne, it varied between 23.23 and 28.11; according to Ragsby, 17.48; according to Lehmann, it varied from 17.56 to 21.02; according to Von Bibra, from 46.79 to 55.01 according to Marchand, from 12.56 to 21.35.

In health the carbonate of lime may vary in different bones from 7 to 8 per cent.; in mollities ossium, according to Bostock, it reached only 1.13 per cent.; according to Prösch, it varied between 5.95 and 4.60. according to Bogne, between 0.94 and 1.07 according to Ragsby, 6.32; according to Lehmann, between 3.04 and 4.08; according to Von Bibra, between 4.94 and 7.49; according to Manchard, between 3 and 3.70 per cent.

In healthy adult bones the cartilage may vary between 32 and 36 per cent.; in mollities ossium, according to Bostock, it reached 70.75 per cent.; according to Prösch, it varied between 49.77 and 74.64; according to Bogne, between 63.42 and 70.60; according to Lehmann, between 41.54 and 50.48; according to Von Bibra, between 29.17 and 32.54; according to Marchand, between 61.20 and 75.22; according to Rees, the animal matters varied between 67.50 and 73.87; according to Garrod, 58.37 per cent.; according to Buisson, 54.37 per cent.

It remains that a comparison should be instituted between the composition of the bones in health, in mollities ossium, and in various diseased states, in order that we may determine whether these changes are characteristic of the disease under consideration.

The results of some of the most trustworthy analyses, by the best chemists, will be found in the following tables:

BLE.—*Composition of Healthy Bones (Human) according to Von Bibra, Berzelius, Thomson, Marchand, Valentin, and Lehmann.*

AUTHOR OF ANALYSIS.	SUBJECTS.	BONES.	Phosphate of lime and fluoride of calcium	Carbonate of lime...	Phosphate of magnesia........	Salts insoluble in water	Cartilage	Fat	Soda and chloride of sodium	Organic matter in cartilage......
Von Bibra	Male fœtus, 6 to 7 months	Femur	53.46	3.06	2.10	1.00	40.38	traces		
...	... ...	Tibia	53.46	3.10	2.00	1.07	40.37	traces		
...	... ...	Humerus	53.15	3.05	1.96	1.02	40.82	traces		
...	Female fœtus 7 months	Ulna	57.63	5.86	1.10	0.60	84.78	0.63		
...	... ...	Radius	57.67	5.89	0.99	0.67	34.08	0.50		
...	... ...	Clavicles	56.95	5.75	1.07	0.73	34.54	0.96		
...	... ...	Scapula	57.13	5.99	1.12	0.62	34.33	0.82		
...	Infant, 2 months	Tibia	57.54	6.02	1.03	0.73	33.86	0.82		
...	... ...	Ulna	56.35	6.07	1.00	1.65	34.92	1.01		
...	... 9 months	Femur	48.11	6.12	0.97	1.23	47.71	1.86		
...	... ...	Tibia	48.53	5.79	1.00	1.24	41.50	1.92		
...	... ...	Humerus	50.15	6.13	1.00	1.30	39.54	1.89		
...	... ...	Ulna	48.06	6.20	1.01	1.24	41.79	1.79		
...	... ...	Radius	45.38	5.11	0.95	1.07	45.65	1.83		
...	... ...	Ribs	42.32	5.60	0.89	1.09	48.55	1.15		
...	... ...	Scapula	42.61	5.08	1.92	1.10	48.36	1.93		
...	Female child, 5 months	Femur	59.96	5.91	1.24	0.69	31.28	0.92		
...	... ...	Tibia	59.75	6.00	1.34	0.63	31.34	0.95		
...	Girl, 19 years	Femur	54.78	10.90	1.34	0.83	31.16	1.00		
...	... ...	Humerus	54.84	10.82	1.26	0.79	31.37	0.92		
...	Woman, 25 yrs.	Femur	57.12	8.90	1.70	0.60	29.54	1.82		
...	... ...	Tibia	57.18	8.93	1.70	0.61	29.58	2.00		
...	... ...	Humerus	58.03	9.04	1.59	0.59	29.66	1.09		
...	... ...	Ulna	57.52	8.97	1.71	0.67	29.14	1.99		
...	... ...	Radius	57.38	8.95	1.72	0.63	29.43	1.89		
...	... ...	Ribs	52.91	8.66	1.40	0.60	33.06	2.37		
...	... ...	Clavicles	56.35	8.88	1.69	0.59	30.66	1.83		
...	... ...	Vertebræ	44.28	8.00	1.44	0.53	43.44	2.31		
...	... ...	Fibula	57.39	8.92	1.63	0.60	29.49	1.97		
...	... ...	Scapula	54.76	8.58	1.53	0.51	32.90	1.73		
...	... ...	Metacarpus	57.77	8.92	1.58	0.61	29.23	1.89		
...	... ...	Cranium	57.66	8.75	1.69	0.63	29.87	1.40		
...	Man, 25 years	Femur	59.63	7.33	1.32	0.69	29.70	1.53		
...	... ...	Tibia	58.95	7.08	1.30	1.70	30.42	1.55		
...	... ...	Humerus	59.95	7.76	1.09	0.72	29.28	1.28		
...	... ...	Ulna	59.30	7.35	1.35	0.73	29.98	1.29		
...	... ...	Ribs	56.66	6.64	1.07	0.62	33.97	2.04		
...	... ...	Cranium	38.43	8.00	1.40	0.90	29.92	1.35		
...	... 58 years	Comp't sub. of femur	58.23	8.35	1.03	0.92	31.47	1.35		
..	... ...	Spongy bone of femur	42.82	19.37	1.00	0.99	35.83	1.35		
...	Woman, 62 yrs.	Femur	61.17	4.46	1.29	0.90	28.03	2.15		
...	... 76 yrs.	Femur	57.36	7.48	1.10	0.97	33 16	0.93		
Berzelius,	Human bone	Bones	53.04	11.30	1.16	...	37.17	...	1.20	
Thomson.	Human	Femur	48.67	14.00	0.49	...	39.72	...	2.50	
...	...	Femur	51.12	9.77	0.63	...	35.93	...	0.59	
Marchand,	Man, 30 years	Femur	53.26	10.21	1.05	...	32.25	...	1.17	
Valentin,	... 38 years	Tibia	52.93	7.66	0.25	...	38.02	...	1.10	
Lehman,	... 40 years	Humerus	56.61	9.20	1.08	...	...	...	1.72	51.52
...	... ...	Radius	52.25	9.76	1.06	...	...	...	1.72	33.76
...	... ...	Ulna	53.98	9.51	1.07	...	...	...	1.38	33.23
...	... ...	Femur	58.93	9.28	1.09	...	...	...	1.44	28.61
...	... ...	Fibula	52.99	9.33	1.06	...	...	...	1.44	34.13

Composition of Bones in Mollities Ossium (Osteomalacia).

	Vertebra. (Bostock.)	Vertebra. (Prosch.)	Costa. (Prosch.)
osphate of lime..	13.60	13.25	33.66
osphate of magnesia..	0.82	......	....
rbonate of lime..	1.13	5.95	4.60
lphate of lime and sulphate of soda..........................	4.70	0.90	0.40
rtilage..	79.75	74.64	49.77
ts..	......	5.26	11.63

An analysis, by Bogne, of the bones of a man aged thirty-two years who died from Osteomalacia, yielded the following results:

	Scapula.	Radius.	Femur.	Patella.
Phosphate of lime	26.92	28.11	23.50	23.23
Carbonate of lime	0.98	1.07	0.97	0.94
Phosphate of magnesia	5.40	6.35	5.07	5.03
Cartilage and vessels	65.85	63.43	69.77	70.60
Soda, iron and loss	0.85	1.05	0.69	0.64

Ragsby analyzed a rib in this disease, and found—

Phosphate of lime and magnesia	17.48
Carbonate of lime and salts	6.32
Cartilage, vessels, and fat	76.20
Specific gravity	0.721

After the removal of the fat, Lehmann found—

	1.	2.	3.
Phosphate of lime	36.86	31.71	35.87
Other salts	4.96	7.91	5.68
Cartilage.	58.16	60.36	58.4

In two cases of Osteomalacia, occurring in persons aged about forty years, Lehmann found—

	(1)		(2)	
	Femur.	Costa.	Femur.	Costa.
Phosphate of lime	17.56	21.02	18.83	19.14
Carbonate of lime	3.04	3.27	3.83	4.08
Phosphate of magnesia	0.23	0.44	0.54	0.60
Soluble salts	0.37	0.63	0.43	0.41
Cartilage	48.83	50.48	41.54	42.43
Fats	29.18	23.13	34.15	32.65

The three following analyses of bone in Mollities Ossium were made by Von Bibra:

	Tibia of a woman aged 75 years.	Femur of a woman aged 83 years.	Femur of a man aged 61 years.
Phosphate of lime with a little fluoride of calcium	55.01	46.79	53.25
Carbonate of lime	4.94	6.37	7.49
Phosphate of magnesia	2.01	1.20	1.22
Salts	0.31	1.37	1.35
Cartilage	29.17	30.90	32.54
Fat	8.58	13.28	4.15

Marchand found the bones of the child, whose case has been noticed under the head of the changes of the urine in Mollities Ossium, composed in the following manner:

	Vertebra.	Radius.	Femur.	Sternum
Phosphate of lime	12.56	15.11	14.78	21.35
Phosphate of magnesia	0.92	0.78	0.80	0.72
Carbonate of lime	3.20	3.15	3.00	3.70
Sulphate of lime Sulphate of soda	0.98	1.00	1.02	1.65
Fluoride of calcium Chloride of sodium Iron and loss	1.00	1.20	1.00	2.01
Cartilage	75.22	71.26	72.00	61.26
Fat	6.12	7.50	7.20	9.34

In a paper published in the twenty-first volume of the *Medico-Chirurgical Transactions*, Dr. Reese demonstrated, by analysis, that the different bones of the adult human skeleton, in health, contained animal and earthy matter in different proportions. Subsequently Dr. Reese had an opportunity of examining some bones affected with Mollities, and the following is the result of careful analyses of three specimens from the same adult subject:—they are compared with those obtained from healthy bones.

	MOLLITIES.		HEALTH.	
	Earths.	Animal matter.	Earths.	Animal matter.
Fibula	32.50	67.50	60.02	39.98
Ribs	30.00	70.00	57.49	42.51
Vertebra	26.13	73.87	57.42	42.58

Dr. Reese observes: "On examining this table it will be observed that in the diseased, as well as the healthy bone, the fibula contains more earthy matter than either the ribs or vertebra; and the ribs more than the vertebra; thus we have the same order preserved in health."

It may be noticed that the vertebra and ribs in health approach very nearly in their proportions of animal and earthy matter; while in mollities a considerable difference exists between them in this respect. This indicates that though the bones are all acted upon by the absorbents in mollities, yet that the absorption does not go on equally in the bones, some being acted on more than others. There, is however, an approach to an equality of action; for, notwithstanding that the diseased bones have lost about half their earthy matter, yet they keep the same order as regards proportional constitution which we observe in health, viz: the fibula containing more earthy matter than the ribs, and the ribs more than the vertebra.

Having ascertained, by previous experiment, that the earthy matter obtained from the long bones of the extremities contains, as nearly as possible, 86 per cent. of phosphate of lime in health, and that the earthy matter from the trunk bones contained, on an average, 83.03* per cent., I determined on mixing together the earths obtained from the fibula, ribs and vertebra affected with mollities, and subjecting them to analysis. This bone-earth, on examination, proved to contain only 78 per cent. of phosphate of lime. There is evidence here that the absorption of earthy matter by disease is accompanied by a decrease in the proportion of phosphate of lime to carbonate. This would seem to show that the absorbents carry away earthy matter containing a very large percentage of phosphate of lime, for were it otherwise, we should never find bone earth containing so small a percentage as 78 of that earth; the smallest in health being 81.2 of phosphate, to 18.8 of carbonate of lime. That the carbonate is absorbed together with the phosphate of lime in certain though small proportion in these processes, is proved by the fact that bones, even those most changed by the absorption of their earthy matter, are not very greatly removed from healthy bone earth in the general average proportion of phosphates and carbonate of lime. (*Guy's Hospital Reports*, No. 8, April, 1839; No. 9, *Medico-Chirurgical Review*, July 1st, 1839, pp. 246–247, Am. ed.)

The carbonate of lime in the bones analyzed by Dr. G. O. Reese may have been derived from the burning of some organic acid, as the lactic, during the preparation of the bone-earth for analysis, and without the clear demonstration of the existence of the carbonate of lime as such in the bone previous to incineration, we cannot lay much stress upon its apparent or relative increase when compared with the phosphate of lime.

Solly† has given the following analysis of the medullary membrane and osseous substance of an individual affected with osteomalacia. The analysis of the affected bone was made by Dr. Tuson.

	Medullary matter.	Osseous matter.
Animal matter	24.78	18.75
Calcareous phosphates	1.83	29.17
Water	73.39	52.08

The chemical examination of a case (detailed by Dr. Ramsbotham, in the reports of the Pathological Society*) by Dr. Garrod, yielded:

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* This average was drawn from results obtained from seven specimens; the extremes were 81.2 and 85.0.

† Medico-Chirurgical Transactions, vol. xxvii, p. 435.

* Reports, &c., 1847–48.

Fatty matter	20.35
Gelatin yielding matter	58.37
Carbonate and phosphate of lime and phosphate of magnesia	21.28

M. Barruel, Jr., found 18 parts of earthy salts, and 82 of organic matter, in 100 parts of bone affected with osteomalacia. The bones of the forearm, which were less softened, afforded 29 of salts and 71 of organized matter, per cent.

Dr. Buisson, in a thesis published in 1851, gives the following analysis of the inferior extremity of the femur of a female suffering from osteomalacia. She was thirty-eight years of age, and her bones had been fractured more than eight times.

Cartilage	54.37
Phosphates	39.16
Carbonates	6.47

These analyses, says the author, prove that the same results are obtained, whether the bones be softer or more fragile than in health. In all cases there is a considerable decrease of the organic matter. (Simon's *Animal Chemistry*, p. 601. Becquerel and Rodier, *Pathological Chemistry*, p. 507. Rokitansky's *Pathological Anatomy*, vol. iii, p. 144.)

On the other hand, as the basis of comparison, we have given the composition of healthy bones.

Von Bibra has made the most complete analyses of human bone, and the results of his elaborate labors are especially valuable, as serving the purpose of comparison with diseased bones, as he has carefully separated and determined the proportion of fat; whilst the analyses of Berzelius, Thomson, Marchand, Valentin and Lehmann, do not furnish the proportions of this important constituent of healthy bones. The determination of the proportion of fat in the healthy bone, assumes a position of transcendent importance as the starting point for the determination of the amount and character of the alteration and degeneration of bone in various diseased states, and especially in those diseases of the osseous system which, like mollities, is associated with *fatty degeneration.* The results of the analyses of Von Bibra will be found in the following table, together with those of several other distinguished chemists.

In the following table it will be seen that, in rickets, according to the analyses of MM. Pelouze and Fremy, it appears that the decrease of calcareous matters was even greater than in individuals suffering from mollities ossium; and in the analysis by Marchand, the calcareous salts, and especially the phosphate of lime, are greatly diminished, and the proportion between the organic and inorganic matters is precisely the inverse of what it is in health. The analysis of bones affected with rachitis yields, therefore, results similar to those announced for mollities ossium, viz: decrease of phosphate of lime, and increase of the cartilaginous and fatty matters. It will be seen, however, that the fatty matters are increased much more uniformly, and to a far greater extent than in mollities ossium.

In caries there is a marked decrease of the proportion of phosphate of lime; in some cases a slight increase of the carbonate of lime; no appreciable change in the proportion of the phosphate of magnesia and soluble salts; normal proportion of cartilage, and a frequent and decided increase of adipose matter.

The few analyses in necrosis indicate a slight diminution of the cartilaginous substance, an increase of calcareous salts and the normal proportion of adipose matter.

In the tophaceous deposits of chronic arthritis there is decrease of the phosphate of lime, increase of the carbonate of lime, and great increase of the adipose matter.

Whilst, therefore, this comparison establishes analogous changes in the bones of certain diseases, as caries, necrosis, and arthritis, at the same time we have a demonstration that mollities ossium is especially characterized by the dengeneration of the osseous structure into fatty matter. We cannot agree with those pathologists who see nothing in this disease but a fatty degeneration of bone. In those diseases, as caries and arthritis, in which we have a similar change, but to a less degree, we have inflammatory action; and

Table.—*Chemical Composition of Diseased Bones in Rachitis, Caries, Necrosis, Osteoposis, Sclerosis Exostosis, Osteoid Tumor, Arthritis, and Callus. By Lehmann, Ragsby, Von Bibra, Pelouze Valentin, Lassaigne, Marchand and Simon.*

Number of Case......	Author of Analysis.	Disease.	Bones.	Phosphate of Lime and Chloride of Calcium...........	Carbonate of Lime.	Phosphate of Magnesia..........	Salts insoluble in water..........	Catilage..........	Fat..........	Organic matter......
786	Lehmann	Rachits	Tibia	32.04	4.01	0.98	0.75	54.84	5.84	
787	...	...	...	26.94	4.88	0.81	1.08	60.14	6.22	
788	...	...	...	28.13	3.75	0.87	1.01	58.77	6.94	
789	Ragsby	... child	Scapula & humerus	15.60	2.66	2.66	0.62	81.12	6.94	
790	Von Bibra	... ...	Ulna	48.83	7.42	1.23	1.82	35.61	6.09	
791	Pelouze and Fleming	... ...	Dorsal vertebra	13.60	1.13	0.82	1.82	79.75	6.09	
792				......	......	......	......	......		
	...	... ...	... ...	13.25	5.95	0.82	1.82	74.64	5.26	
	...	... ...	Ribs	33.60	4.60	0.82	1.82	49.77	5.26	
	...	... ...	Cranium	26.92	5.40	0.98	0.85	65.85	11.63	
	...	... ...	Radius	28.11	6.35	1.07	1.05	63.42	11.63	
	...	... ...	Femur	23.50	5.07	0.97	0.69	69.77	11.63	
793	Marchand	... ...	Patella	23.23	5.03	0.94	0.64	70.60	11.63	
	...	... ...	Vertebræ	12.56	3.20	0.92	1 00	75.22	6.12	
	...	... ...	Radius	15.11	3.15	0.78	1.20	71.26	7.50	
	...	... ...	Femur	14.78	3.00	0.80	1.00	72.20	7.20	
794	Valentin	Caries, man	Tibia	34.38	6.63	1.18	1.91	......	7.20	55.88
	...	... ...	Vertebræ	33.91	7.60	0.38	3.27	......	7.29	54.83
	...	... girl	Femur	39.39	4 62	0.52	1.17	......	......	54.39
	...	... ...	Tibia	45.45	5.68	1.18	2.06	......	......	45.62
795	Von Bibra	... man	Metacarpi	49.77	7.24	1.11	0.30	37.97	3.61	
	...	... ...	Metacarpal bones	31.36	4.07	0.83	0.30	59.36	4.08	
	...	... ...	... ...	49.36	8.08	0.98	0.40	37.47	3.71	
	...	... ...		51.53	5.44	3.43	0.91	35.69	3.00	
	...	... ...	Femur	54.98	5.97	3.70	0.89	31.44	3.02	
796	...	... woman	...	45.14	5.03	2.40	0.82	42.34	4.27	
797	...	... man	Patella	39.22	6.87	0.50	2.10	29.23	22.09	
798	...	... girl	Tarsus	45.77	3.77	1.45	1.10	38.62	9.29	
	...	... woman	Vertebræ	44.05	3.45	1.02	1.70	41.42	8.36	
799	...	... man	Tibia	47.79	6.44	1.30	2.00	28.57	13.60	
	...	Necrosis ...	Phalanges	72.63	4.03	1.93	0.61	19.58	1.22	
	...	... ...	Bone	60.77	4.03	1.93	......	......	1.36	38.87
	...	... ...	Fracture	67.33	4.03	1.93	......	......	1.09	31.58
800	Ragsby	Osteoposis	Cranium	55.80	5.59	1.93	......	......	......	38.61
	...	Sclerosis, man	...	54.10	10.45	1.00	1 04	33.41	......	
	...	...	...	48.20	7.45	......	0.25	44.10	......	
	...	...	...	50.29	7.20	......	0.25	42.51	......	
	...	...	...	55.52	5.95	......	0.26	38.27	......	
	...	...	Femur	53 21	8.30	......	......	38.49	......	
801	...	... syphilitic	...	57.20	6.50	......	......	86.30	......	
802	Lassaigne	Exostosis	Thickened bone	36.3	6.5	......	14.2	36.30	......	43.0
	...	...	Exostosis	30.0	14.0	......	10.0	36.30	......	46.0
803	Simon	Osteoid tumor	Knee-bone	38.85	2.70	0.58	0.78	58.91	1.16	
	...	... ...	...	8.00	0.62	0.21	0.39	87.04	3.61	
	...	... ...	...	9.20	0.64	0.21	0.72	86.20	3.21	
804	Marchand	Arthritis, tophaceous deposit	Femur	42.12	8.24	1.01	2.31	86.20	......	46.32
				......	......	......	......	......	......	
	...	... ...	Radius and ulna	43.18	8.50	0.99	1.37	86.20	......	45.94
805	Lehmann	Arthritis, chronic gout	...	35.16	8.41	1.31	2.93	38.14	12.11	
				......	......	......	......	......	......	
	...	... ...	...	35.83	9.82	1.06	2.03	38.20	13.37	
	...	... ...	...	37.02	8.99	1.13	1.82	40.03	9.15	
806	Lassaigne	Callosities	...	33.3	5.7	1.13	11.3	40.03	......	50.0
	...	...	...	32.5	6.2	1.13	12.8	40.03	......	48.5

the true and most important question with reference to mollities ossium is the determination of the causes which led to such an alteration of the bones as led, not merely to the absorption of the earthy salts, but also to the effusion of inflammatory products in the bony structure, and their final conversion into fatty matter, as in those diseases which are, in their inception, truly inflammatory.

The view that the earthy phosphates, in mollities ossium, were removed by some acid generated in the living system, was suggested at an early day in the history of the disease; and, in fact, this idea appears to have been suggested by the effects of acids upon healthy bones in rendering them flexible like cartilage.

Dominic Gagliardi, who, discoursing upon the observation of Gabrielli upon mollities ossium, in 1689, supposed that the earthy matter of bony *gypsum*, as he called it, is softened in consequence of its being alkaline, by the acids which are thrown into the vessels of the bones; and that from hence it is that persons subject to rheumatic and arthritic pains, but peculiarly to pains from "lues venerea," are also subject to have their bones become soft. This statement led to the experiments of softening the bones by means of acid liquors.

Morgagni adopted the same opinion, and conjectures that a *humor* is carried into the bones which is capable of softening them, and refers to the experiments of Ruysch. who showed that acid liquids would remove the earthy particles, and render the bones so soft and elastic as to be bent into any shape.

Ruysch, in recording his experiments, makes the following application in the form of a query: "Does it from hence appear in what manner that memorable disease was brought about wherein a virgin, in France, being affected, had all her bones softened down like paste?"

More recently Marchand has propounded a chemical theory of mollities ossium and rickets, which is a further elucidation of the old idea of the action of an acid humor in the blood. This theory of Marchand we have thrown into three propositions as follows:

1. The diseases which exert the greatest influence over the condition of the bones. altering them from their normal state, are scrofulous affections, to which rickets and mollities ossium may be considered as belonging.

In these two diseases, the earthy matter of the bone becomes diminished, and the bone falls into a state such as if it had been macerated in muriatic acid; supple; flexible and ill-adapted to serve as a support to the other organs of the body. The cartilage itself undergoes an essential alteration, and is incapable of being converted by boiling into gelatine.

2. Concurrently with these changes, phosphate of lime is eliminated in large quantities with the urine. This salt, otherwise little soluble, and discharged generally in small quantity by the kidneys, is, according to Berzelius, readily soluble in lactic acid; anything, therefore, which causes a superabundance of this acid in the system, is capable of depriving the organism of a large share of the earthy matter of the bones.

Sugar of milk, grape sugar, starch, and gum are readily converted into lactic acid. but they are so in the stomach only when digestion is ill-performed, in which case lactic acid may be an abundant product in the system.

3. Rickets and mollities ossium, therefore, are not essentially diseases of the bones. but seem to be the result of imperfect digestion or nutrition; to improve which is consequently our first indication.

None of the substances readily converted into lactic acid should be taken as sugar. starch, gum, etc., nor even milk (rickets are often the consequence of children having been too long suckled,) but animal food and such other as is freely digestible. should be chosen, in aid of which we ought to employ such medicines as may restore the general tone of the system

This chemical theory of Marchand is sustained by the discovery of increased quantities of lactic acid and lactates in the urine of rickets and mollities ossium; and by the actual discovery of lactic acid in the diseased bones of the latter disease.

C. Schmidt proved clearly that free lactic acid was present in the fluid of the cylindrical bones in this disease; and Lehmann states that the fluid occurring in these bones exhibits *very often*, although not invariably, an acid reaction. Weber, who alone appears to have investigated the composition of the phosphate of lime contained in these bones, found in addition to carbonate of lime $\frac{8}{3}$ basic phosphate of lime, and believes that phosphate of normal bone ($3CaO,PO_5$) is converted by means of the free acid into this less basic salt.

The singular and painful disease of the jaw-bones, produced by the fumes of phosphorus and phosphoric acid,* renders it probable that in mollities ossium, most of the pain and irritation of the bones may be caused by the liberation of phosphoric acid in the phosphate of lime which has been subjected to the action of the *free* lactic acid.

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*For an interesting account of the Diseases of Workmen engaged in making Lucifer Matches, see American Journal of the Medical Sciences, Oct. 1846, N. S., vol. xii., p. 525.

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